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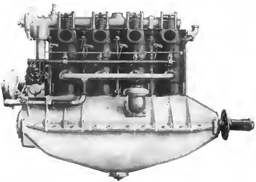

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FEBRUARY 15, 1917 **AVIATION** AND AERONAUTICAL ENGINEERING VOL. II. NO. 2

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THE GARDNER, MOFFAT COMPANY, Inc., *Publishers*
120 WEST 32D STREET NEW YORK

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ISSUED ON THE FIRST AND FIFTEENTH OF EACH MONTH FORMS CLOSE FIVE DAYS PREVIOUSLY. ENTERED AS SECOND-CLASS MATTER, AUGUST 3, 1916, AT THE POST OFFICE AT NEW YORK N. Y. UNDER ACT OF MARCH 3, 1879

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AVIATION AND AERONAUTICAL ENGINEERING

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Vol. II February 15, 1917 No. 2

EVER since President Wilson severed diplomatic relations with Germany it has been apparent that this country has been on the brink of war. It is not prepared to face a war in the air. It is not fair that hysterical appeals for more aviators be allowed to confuse the situation and to divert the attention of the public from the real aeronautical need of the United States which is for more types of planes especially for more fighting planes, scouts, pursuit machines, long-range reconnaisance machines, armored airplanes and bombers.

American training machines are the equals of any in the world. The fact that we are building good training machines gives promise for the future, but the tense diplomatic situation makes the fact that we shall probably have some good machines for military and naval work a year from now seem of very little importance. American airplane workmanship can attain the highest standards, but the training machine type is not useful in war.

Today neither the United States Army or Navy can obtain immediately airplanes fit to cope with the military machines that are in daily use abroad. It is imperative that we should hasten the development of military airplanes for army and naval use, but there is very little prospect that we shall have such machines in any considerable quantities for some time to come.

No one is to blame for this situation except the legislators in Congress, who, up to last August refused repeatedly to appropriate the substantial sums of money without which it was impossible to expect that the airplane industry in this country would flourish.

The fact that large appropriations for both the Army and Navy were made last August, so that the two branches of the service had altogether in the neighborhood of $17,000,000 at their disposal for the current fiscal year, has not helped matters to any great extent insofar as the immediate deliveries of battleplanes are concerned.

The development of an aeronautical engine is a matter of a year at least. That we have a number of satisfactory engines of 150 horsepower and less is an immense step in advance of the situation that existed a year ago but it is due almost as much to the hope on the part of the manufacturers that they would be able to sell abroad as it is to the stimulation of the appropriations of last August. The results of the encouragement which that appropriation gave to the industry will not become tangibly available for six months more at least, and it would be unreasonable to expect engines of greater horsepowers to reach a production basis until then.

Now that we have the engines we have only just begun to solve the problems of military aviation. No designer can begin to draw up plans for an airplane until he has determined upon the engine which is to go into it. It is now necessary to begin to build planes around the engines that have only just been perfected. This is a work that will require at least another year of intensive development and experimental flying before the solution is approached.

Any visitor to the recent Aeronautical Exposition who did not gain an appreciation of the fact that the design of an airplane is a delicate engineering problem requiring months of careful thought and experimentation failed to grasp the chief lesson of that exposition.

The United States Army has suggested that the so-called two place reconnaisance tractor is a false development. It may be valuable against an enemy who has no airplanes, but against an enemy who is prepared it has practically no military or naval value. Yet that was almost the only type of machine which the constructors found available for exhibition.

The United States Navy has announced that it needs machines of great weight-carrying ability and large fuel-carrying capacity. No such machines were shown. The pressing need of today is not only for more thoroughly trained aviators, it is for more machines and more types of machines. Whenever the constructors are in a position to deliver military types of airplanes in quantities, the country will have the aviators to fly them.

The personnel and material problems both need to be solved. The personnel problem is comparatively easy of solution because so long as the attraction of flying as an adventure remains, there will be no lack of young men who are willing to learn to fly at the Government's expense. But there is no use in training civilians to fly unless some possibility exists of fitting the aviators out with fighting machines when war comes.

The Cover Photograph

The cover of this issue shows the first airplane to fly, the original Wright machine of 1903, restored to the condition in which the Wright Brothers used it. Orville Wright and Glen L. Martin are in front of the plane and between them is the Michelin trophy, won by the late Wilbur Wright in France in 1908 for a flight of 77 miles in 2 hours and 20 minutes.

Notes on Speed Indicators for Airplanes

The Venturi Tube

By Winslow H. Herschel
of the Bureau of Standards

Bourdon* used a Venturi tube as an anemometer in mines, and it has been used more recently as a speed indicator on airplanes. A Venturi tube consists of a converging cone, forming a mouthpiece of approximately the shape of a vena contracta, followed by a diverging cone, usually with a short cylindrical throat between the two. The diverging cone must have a small angle, about 5 degrees, so as to reduce the frictional loss to a minimum. The difference between the pressure at the upstream end of the converging cone, and at the throat, is a measure of the velocity.

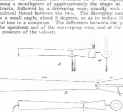


Fig. 1. Types of Venturi Tubes

(A) A standard Venturi tube (B) A double Venturi as per writ dimensions in millimeters (C) A combination of the Venturi and Pitot tubes

When the Venturi tube is inserted as a section of a pipe line, and is used to measure discharge, this pressure difference expressed in height of water column, and known as the "head on Venturi," indicates the velocity through the throat.† For the present purpose it seems preferable to find the velocity at the upstream end, which is more nearly equal to the desired velocity of flight.

Let p_1, ρ_1 and v_1 be the pressure, density and velocity, respectively, at the upstream end where the section is A_1 and let p_2, ρ_2 and v_2 represent the same quantities at the throat, where the section is A_2. Assuming adiabatic expansion, the well-known formula of de Saint-Venant will apply

$$\frac{v_2^2 - v_1^2}{2g} = \frac{\gamma}{(\gamma-1)}\frac{p_1}{\rho_1}\left[1-\left(\frac{p_2}{p_1}\right)^{\frac{\gamma-1}{\gamma}}\right] \qquad [1]$$

where γ is the ratio of specific heats, c_p/c_v, which may be taken as 1.4 for air. This formula may also be applied to Pitot tubes, in place of equation $V = K\sqrt{\frac{h}{\rho}}$, but the increase in accuracy is not sufficient to compensate for the greater complexity.

Since $A_1 v_1 \rho_1 = A_2 v_2 \rho_2$

and $\frac{\rho_2}{\rho_1} = \left(\frac{p_2}{p_1}\right)^{\frac{1}{\gamma}}$

therefore $\frac{v_2}{v_1} = \left(\frac{A_1}{A_2}\right)\left(\frac{p_1}{p_2}\right)^{\frac{1}{\gamma}}$ [2]

For dry air, at a temperature of 70 degrees Fahrenheit (21 1 degrees C), Equation 1 may, with the help of Equation 2, be reduced to

$$v_1 = 2522\sqrt{\frac{1-(p_2/p_1)^{\frac{\gamma-1}{\gamma}}}{\left(\frac{A_1}{A_2}\right)^2\left(\frac{p_1}{p_2}\right)^{\frac{2}{\gamma}}-1}} \text{ feet per second} \qquad [3]$$

where the coefficient, 2522, is equal to $\sqrt{7gRT} = \sqrt{7g\,53.31\,(460+70)}$ in English units

In using metric measures, equation 3 is unchanged, except that the coefficient has a value of 768 7 to give velocities in meters per second.

TABLE 1

Theoretical Heads on Venturi Tubes in Inches and Corresponding Velocities in Miles per Hour for Various Pressure Ratios and Elevations

Throat ratio = 1/2

P_1/P_2	71° 0 29 92		67° 1000 28 86		64° 2000 27 78		60° 3000 26 77		57° 4000 25 76		53° 5000 ft elev 24 78 in barometer	
	h	v	h	v	h	v	h	v	h	v	h	v
1 030	12 2	39 8	11 8	40 7	11 1	41 0	10 9	40 4	10 5	40 1	10 1	[illegible]
1 035	14 2	42 8	13 7	42 7	13 2	42 5	12 7	42 4	12 3	42 1	11 8	[illegible]
1 040	16 3	45 9	15 7	45 1	15 1	46 2	14 5	45 1	14 0	45 0	13 5	[illegible]
1 045	18 3	48 0	17 6	47 9	17 0	48 7	16 4	47 8	15 8	47 5	15 2	[illegible]
1 050	20 1	50 7	19 6	50 2	18 9	51 0	18 2	49 8	17 5	49 7	16 8	[illegible]
1 06	24 4	54 9	23 5	54 0	22 6	54 2	21 8	54 1	21 0	54 0	20 2	[illegible]
1 07	28 4	58 4	27 4	58 2	26 4	58 1	25 5	57 7	24 5	57 7	23 6	[illegible]
1 08	32 8	61 8	31 3	61 0	30 2	61 4	29 1	61 2	28 0	61 1	26 9	[illegible]
1 09	36 0	64 9	35 2	64 1	33 9	64 5	32 7	64 3	31 5	64 2	30 3	[illegible]
1 10	40 8	67 7	39 2	67 5	37 7	67 4	36 3	67 4	35 0	66 9	33 6	[illegible]
1 11	44 7	70 3	43 1	70 0	41 5	70 0	40 0	69 7	38 5	69 5	37 0	[illegible]
1 12	48 6	72 7	47 0	72 5	45 2	72 3	43 6	72 1	42 0	71 8	40 4	[illegible]
1 13	52 8	75 0	50 9	74 8	49 0	74 5	47 3	74 3	45 5	74 2	43 8	[illegible]
1 14	56 8	77 1	54 8	76 8	52 8	76 5	50 9	76 3	49 1	76 2	47 1	[illegible]
1 15	60 9	79 8	58 7	78 8	56 5	78 5	54 5	78 4	52 5	78 2	50 5	[illegible]
1 20	81 1	87 2	78 4	86 8	75 3	86 3	72 7	86 2	70 1	86 0	67 3	[illegible]
1 25	104	91 9	97 9	93 0	94 2	92 0	90 8	92 3	87	92 2	84 2	[illegible]
1 30	122 1	97 1	117	97 0	113 1	97 3	109 1	97 0	111	96 8	101 0	96

With a temperature of 32 degrees Fahrenheit (0 degrees C.) the coefficient would be 2430, in English units, and would have a value of 2593 at 100 degrees Fahrenheit (37 8 degrees). The error due to temperature changes would therefore not exceed 1 per cent so long as the temperature remained between these limits.

The error due to change of barometer cannot be expressed by a change in coefficient, since Equation 3 contains a pressure ratio, while a pressure difference is read from the manometer. The relation between these quantities is given by the equation

$$h = \left(\frac{P_1}{P_2} - 1\right) 13\ 596\ B$$

where h is the pressure difference in inches of water and B is the height of the barometer in inches of mercury.

If the ratio of throat diameter to entrance diameter to "throat ratio," is 1/2, which is approximately the value used in Bourdon's apparatus, $(A_1/A_2)^2$ of Equation 3 has the value of 16. With this value, and with the help of Equations 3 and 4, Table 1 has been calculated showing heads on Venturi, h, and corresponding velocities in miles per hour, v, for different elevations. A drop in temperature of 1 degree Fahrenheit per 300 feet rise has been assumed, but it will be noted that the effect of this change of temperature on the computed value of v is small in comparison with the effect of the change in barometer upon the value of h.

Fig. 2 shows more clearly than does Table 1 the total error due to using a fixed scale to give velocity from readings of the head on Venturi. This error, which is found to decrease from about 7 to 4 per cent as the speed increases, does not take into account possible changes in temperature at the earth's surface, which might increase or decrease the error.

It would appear from a comparison of Fig. 2 and Table 2, in the article on the Pitot Tube in Aviation and Aeronautical Engineering, January 15, 1917, page 385, that there would be little choice, between a Pitot tube and a Venturi tube, as regards the error due to changes in air density. There is, however, considerable uncertainty as to the extent to which the Venturi tube conforms to the theoretical formula, Equation 3. Table 2, printed herewith, shows comparative heights of water column according to Bourdon's experimental results, equation $1 = A\sqrt{\frac{h}{\rho}}$ and Equation 3, with the throat ratio equal to 1/2.

While Bourdon's tests do not agree very well with theory, and do not cover velocities that are of importance in connection with airplanes, they indicate that the water column, with

* R Bourdon, *Annales des Mines*, September and October, 1881 Comptes Rendus, 1882, pp. 229

† T R Weymouth Transactions American Society of Mechanical Engineers 1912 page 1091 L V King Journal of the Franklin Institute August 1915

a Venturi tube, would probably be at least five times as high as with a Pitot tube. Since the air inside the Venturi tube is retarded by friction against the walls, its velocity, at the upstream end, would be less than the velocity of the air outside

TABLE 2

Comparison of Theoretical and Observed Heads Produced at Various Wind Velocities on a Venturi Tube with Throat Ratio of 1/2 and on a Pitot Tube

1 Air Velocity		2 Theoretical Head on Venturi		3 Head on Venturi According to Bourdon		4 Pitot Tube Head		5 Col. 2 / Col. 4
Miles per Hour	Meters per Second	Inch	Mm	Inch	Mm	Inch	Mm.	
10	4 47	0 7	19	0 17	4	0 05	1 3	3 4
20	8 94	2 9	74	0 80	20	0 18	4 6	4 2
30	13 41	6 8	173	2 30	58	0 43	10 9	5 3
40	17 88	12 3	312			0 77	19 6	
50	22 35	20 0	508			1 20	30 5	
60	26 82	30 0	762			1 73	43 9	
70	31 29	45 0	1143			2 35	59 7	
80	35 76	63 0	1600			3 07	78 0	
90	40 23	90 0	2286			3 89	98 8	

the tube, which is to be measured. This may account, in part, for the disagreement between columns 2 and 3 of Table 2. There is also doubt as to the accuracy with which Bourdon's tests were made.

The maximum throat velocity, v_2 will be reached, as with a nozzle* when

$$\frac{P_2}{P_1} = \left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}} = 0.528 \text{ for air} \qquad [5]$$

and a maximum velocity at the upstream end, v_1 of 113 miles (182 kilometers) per hour was obtained by introducing this value of the pressure ratios in Equation 3.

If the throat ratio had been 1/4 instead of 1/2, the maximum velocity would have been only 50 miles (80 kilometers) an hour, though heads corresponding to a given velocity would have been much increased. Thus by a change of throat ratio, suitable heads may be obtained for almost any desired range of velocities. A throat ratio of 1/2 would be about right for airplane use at speeds below 100 miles (161 kilometers) per hour.

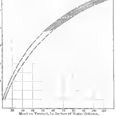


Fig. 2

Bourdon wanted an anemometer for very low velocities, and in order to magnify the head on Venturi he used two or three concentric Venturi tubes, the discharge end of one tube being placed at the throat of the next larger tube of the series. Table 3 gives the proportions of his double tube.

* A Stodola, Die Dampfturbinen 3rd edition page 8

† E. Dorand, *La Technique Aéronautique* Nov 1 1911 page 252

‖ A. Toussaint and G Lepère, Bulletin de l'Institut Aérotechnique de l'Université de Paris, Fascicule III 1913 quoted in Report British Advisory Committee on Aeronautics, 1912-1913, page 296

TABLE 3

Proportions of Bourdon's Double Venturi Tube Anemometer

	Inner Tube	Outer Tube
Ratio of minimum to maximum diameter		
of converging cone	0 31	0 65
of diverging cone	0 45	0 80
Double angle		
of converging cone	34° 18′	21° 38′
of diverging cone	3° 43′	4° 50′
Relative Throat diameters	1 0	6 2

The length of the speed indicator of the Venturi type, made by Aera, Paris, is 6 3 inches (160 millimeters), or very nearly the length of the downstream cone of Bourdon's inner tube. Dorand † gives a sketch of a Venturi tube, but without dimensions. The proportions recommended by Toussaint and Lepère‖, as a result of their experiments, are similar to those of Bourdon's outer tube.

Toussaint and Lepere made the largest number of tests on Venturi tubes, type I, having a downstream cone angle of 4 degrees 50 minutes and a throat diameter of 10 millimeters (0 39 inch). There was a gap of variable length between the two cones, which was surrounded by a chamber to which the piezometer tube was attached, so that there was in effect a variable throat length, Δ. Their results may be summarized as follows

series	Length of Cones: Upstream l mm	in	Downstream L mm	in	Double Cone Angle, Upstream α	Throat Length Δ mm	in
a	34 4	1 36	160	6 3	13°-10′ 18°-00′ 23°-10′, best	2 7	0 10
b	34 4	1 36	160	6 3	23°-10′	6 2 to 0 7	0 240 0 028
	The efficiency increased as Δ decreased						
c	34 4 30 5 25 5 20 5	1 36 1 20 1.00 0 81	gave the same result, slightly better than the other two.		23°-10′	0 7	0 028
d	20 5	0 81	145 160	5 7 6 3	23°-10′ much the better	0 7	0 028

The result of series a is in accordance with theory, as with l constant, the largest angle would give the smallest throat ratio. The effect of the change in throat length, series b, applies only to a throat with a gap, and the results might have been quite different if there had been a real throat piece, as used by Rowse, with small holes connecting with the piezometer chamber. Series c is inconclusive. The marked effect of the length of downstream cone, series d, which is not taken into account in the theoretical formula, shows that agreement between experiment and theory is not to be expected, but the possibility remains that a still longer cone might have increased the head produced by a given wind velocity, and thus brought the results nearer to the theoretical.

In experiments with other Venturi tube, type B gave inferior results, attributed to their smaller size. Tube No. 5 had a downstream cone of 6 degrees 55 minutes, and other proportions as follows

l = 106 millimeters (4.2 inches) L = 212 millimeters (8 3 inches)
α = 14 degrees throat diameter = 34 millimeters (1 34 inches)

The results obtained were very nearly the same as with the best tube of type I. The authors attribute its good showing to the large downstream cone angle, as compared with type I, but it may be noted that there was no gap between the cones, and this difference in the method of obtaining the head may have had a favorable influence.

The maximum wind velocity given in any diagram is about 23 meters per second (52 miles per hour), which is only slightly above the theoretical limit for a tube with a throat ratio of 1/3, the lowest ratio used with tubes of type B. In the case of the two most efficient tubes tested, type I and No 5, that is, those which gave the greatest head for a given wind velocity, the throat ratio was about 1/2. Since for this throat ratio the theoretical limit of velocity would be over 100 miles per hour, it is evident that the velocities used in the tests were not high enough to furnish a check upon the theory. Neither do the tests give any information upon the variation of head with temperature and with barometer, since all results have been reduced to 15 degrees C (59 Fahrenheit) and 760 millimeters (29 92 inches).

Even with their best tubes, Toussaint and Lepère did not equal the efficiency reported by Bourdon, which may be due either to inaccuracy in his tests or to superiority in the proportions of his instruments. At a velocity of 12 meters per

second (27 miles per hour), the heads obtained were as follows

		Head on Venturi mm	in.
Bourdon	single tube	42	1.58
"	double	168	6.60
"	triple	110	23.60
Toussaint and Lepère	single tube type 1	32	1.26
"	No. 3	33	1.30
" "	double tube C	91	3.58
" "	B	93	[illegible]

Toussaint and Lepère also experimented with a registering speed indicator, but do not explain how to calculate the head from the calibration curve. "The antenna is a combination of a Pitot and a Venturi tube, the pressure and suction, respectively, being communicated to two chambers with movable diaphragms. The two diaphragms are connected so that they move together and actuate the recording pen. Both being exposed to the atmospheric pressure, the recorder is independent of the local pressure conditions obtaining where it is placed. The recorder was calibrated against a standard Pitot."

In many respects the Venturi tube is similar to the Pitot tube. It has a flexible connection between the head and the gauge, and any gauge which can be successfully devised for a Pitot tube could also be used on a Venturi tube, with less difficulty on account of the greater head available. In either instrument the leads from the head to the gauge should be large enough to obviate the danger of a perceptible lag in indications. According to Darwin, in producing sufficient damping to prevent excessive oscillations of the gauge, it is preferable to have long leads of large diameter rather than short tubes of small diameter.

While the Pitot tube has been thoroughly investigated, and it is known how it may be proportioned so as to give results in agreement with theory, there is great need of further experiments on the Venturi tube. More experiments have been made on Venturi tubes for water meters than for anemometers, and yet Hazen* shows that it is still a matter of dispute whether the coefficient c (by which velocities computed by the theoretical formula must be multiplied in order to get actual velocities) is constant or varies with the velocity.

The Venturi tube indicator has proved to give satisfaction in practice. Eiffel† says:

"Lieut. Saunier succeeded in making a number of experimental flights in a straight line through still air. The Venturi tube used to measure the velocity of the airplane was verified by direct measurements made in our air stream. He readings gave exactly the same results as our Pitot tube, removing all doubt as to the precision of the velocity measurements."

Further details are given by Dorand, in the article previously referred to, in which he says:

"Relative velocity was measured by the Venturi tube, ... in use in the laboratory as a gas meter in the hydrogen apparatus. As is known there exists a difference of pressure between a point in the wall near the upstream end and another at the throat. This difference of pressure being nearly proportional to the square of the relative velocity serves to measure that velocity. The depression is measured by means of a manometer with water colored red. The indicator of the air velocities has been calibrated with care on the one hand on the airplane in making direct measurements of velocity with no wind and on the other hand on an automobile. In the two cases the results found were concordant."

The gauge used with the Venturi speed indicator on the Astra appears from the illustration to be of the Bourdon type, and superior to the liquid gauge described by Doran.

All things considered, if a speed indicator is desired which shall have no automatic correction for changes in air density as far as safety in flight is concerned, then the choice lies between the Pitot and Venturi tubes. With the former the pressure available is too small to operate a non-liquid gauge of the types available. With the latter there is a lack of experimental data to show to what extent the theory holds good. While waiting for future experiments to remove this difficulty it may only be stated that the Venturi tube has been found to agree with the Pitot tube at barometric pressures at which it has been calibrated.

* A. Hazen, Engineering News, July 20, 1913, page 108.

† G. Eiffel, The Resistance of the Air, page 234.

The Thomas 150 Horse Power Model 88 Aeromotor

By George H. Abel, Chief Engineer,

Thomas-Morse Aircraft Corporation

Following their Model 8 Aeromotor, the Thomas-Morse Aircraft Corporation of Ithaca, N. Y., has produced a new engine Model 88, bearing a close resemblance to the earlier model. The main features of that model have been retained, in fact, many parts are interchangeable in the two engines. Supported by the great development in the wide use of aluminum, the Thomas engineers have adapted the material for cylinder construction, which adoption forms the main departure from previous accepted design.

It is the purpose of this article to disclose the point of view of the Thomas engineers as to the ends to be obtained and the means utilized to gain those ends in the design of their engine. A mere recital of specifications will be avoided, as such are to be found concisely stated in the Company's catalog. Efforts will be confined to a discussion of the main features only.

HIGH SPEED AND GEAR REDUCTION

The marked tendency to day toward a higher speed of rotation has been conclusively justified, in the opinion of the Thomas engineers, by the continued reliable performance of engines with crankshafts operating at speeds near 2000 revolutions per minute, driving the propeller through suitable gearing at the most efficient speed. High speed demands that the closest attention be paid to the design of reciprocating and rotating parts and their adjacent units. Steel of the highest obtainable tensile strength must be used for connecting rods and piston pins, that they may be light and yet retain a sufficient factor of safety. Piston design is likewise subjected to the same strict scrutiny. At the present day aluminum alloy pistons operate so satisfactorily that they may be said to have come to stay. The aluminum pistons in the Thomas engine weigh only half as much as the cast iron pistons they supplant. In the same way, tungsten steel valves have contributed as largely as any one thing to the success of the high speed engine, while accessories, particularly ignition systems, have been greatly improved in reliability.

The statement often made in the past, that the gearing down of an engine costs more in the weight of reduction gears and propeller shaft than is warranted by the increase in horsepower, is seldom heard to-day.

The mean effective pressure remaining the same, the brake horsepower of any engine increases as the speed. That is, an engine delivering 100 brake horsepower at 1500 revolutions per minute will show 133 brake horsepower at 2000 revolutions per minute, an increase of 33 brake horsepower. To utilize this increase in horsepower, a matter of some fifteen pounds must be spent in gearing and another fifteen perhaps on larger valves, bearings, etc. Two per cent may be assumed lost in the gears. In other words, the increase in horsepower due to increasing the speed has been attained at the expense of about one pound per brake horsepower.

All in all, the advantages of light weight, compactness and ability through suitable gearing to obtain any desired propeller speed, make it appear to the Thomas engineers that the geared down engine is the engine of to-day and to-morrow.

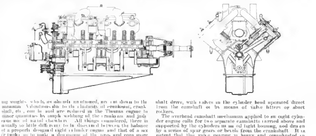
EIGHT CYLINDER, "V" FORM, WATER-COOLING

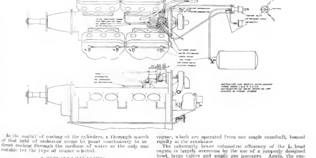
In discussing the arrangement of cylinders, all forms other than six cylinders in line and eight and twelve in "V" form have been considered as either not adapted to installation in airplanes, as with the case of a double V engine, or not having a sufficient number of cylinders to handle the horsepower required at the desired speed.

The advantages of the eight cylinder engine over the six and twelve briefly stated are: lower weight per horsepower, shorter length, simpler and stiffer crankshaft, camshaft and crankcase and simpler and more direct manifold arrangement. As to torque, the eight is superior to the six, and yet in practice not enough inferior to the twelve to warrant the addition of four more cylinders. It must, however, be recognized that the eight is subject to the action of unbalanced horizontal couples, which set up horizontal vibrations, impossible of total elimination. These vibrations are functions of the reciprocating weights, which, as already mentioned, are cut down to the minimum. Vibrations due to the elasticity of crankcase, crankshaft, etc., can be and are reduced in the Thomas engine to minor quantities by ample webbing of the crankcase and judicious use of metal elsewhere. All things considered, there is actually so little difference to be discerned between the balance of a properly designed eight cylinder engine and that of a six or twelve as to make a discussion of the pros and cons more one of theory than of practice.

The valve gear must not be forgotten. A cylinder cannot be taken completely away from its component parts and judged, as to its weight value, in itself alone. A part away from the whole becomes an item unimportant in comparison with the whole. The valve gear of a high speed engine is a too often overlooked feature. The stamp of approval has been made by high speed automobile practice upon the overhead camshaft drive, with valves in the cylinder head operated direct from the camshaft or by means of valve lifters or short rockers.

The overhead camshaft mechanism applied to an eight cylinder engine calls for two separate camshafts carried above and supported by the cylinders in an oil tight housing, and driven by a series of spur gears or bevels from the crankshaft. It is patent that this valve gearing is heavy and complicated in comparison with the simple moving valve units of the L head engine, which are operated from one single camshaft, housed rigidly in the crankcase.





In the matter of cooling of the cylinders, a thorough search of that field of endeavor seems to point conclusively to an direct cooling through the medium of water as the only one suitable for the type of engine selected.

L HEAD AND VALVE GEARING

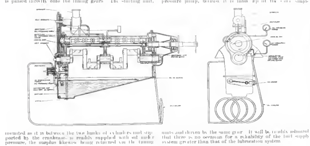
The main criticisms of the L head cylinder engine are that it is less efficient and heavier. This is granted, as it relates to cylinders alone. More thorough investigation, however, based on the main desideratum, weight/power ratio, leads us to other conclusions, particularly with reference to high speed engines.

The inherently lower volumetric efficiency of the L head engine is largely overcome by the use of a properly designed head, large valves and ample gas passages. Again, the customary use of a dual ignition system gives to the L head a relatively better opportunity for the advantageous placing of spark plugs, in order that better flame propagation and complete combustion may be secured. Moreover, the height and breadth of the L head engine is greater, due to its valve gearing, making it difficult to install in an airplane body, while

the removal of a cylinder calls for considerable work in the removal of camshaft and valve gearing. In short, the L head cylinder complete, with its attendant valve mechanism, is as light, far more compact and necessarily more reliable than either of the two usual methods of I head cylinder construction.

LUBRICATION

A high speed engine is no better than its system of lubrication. This statement has been taken as a slogan of design. With it in view, it was natural that a fully forced system of lubrication should be adopted for an engine operating under continuously high bearing pressures. A glance at the cut of the oiling system will show that oil is drawn from the oil pan by a gear pump, spur gear driven from the crankshaft timing gear, and forced through large oil ducts under 50 pounds pressure to the three main bearings, thence through the crankshaft to the connecting rods. The camshaft, drilled hollow, is used as a duct to supply its own bearings. An adjustable pressure regulating valve is so mounted that all surplus oil is passed directly onto the timing gears. The starting unit,



mounted as it is between the two banks of cylinders and supported by the crankcase, is readily supplied with oil under pressure, the surplus likewise being returned via the timing gears.

Continued experience in the operation of high speed, high efficiency engines has proven the necessity for ample cooling of the oil. To this end, the Model 88 is furnished with a supplementary oil circulating pump, that receives oil from the oil pan at the two gallon level and circulates it through 20 odd feet of tubing that may be placed anywhere in a free circulation of air. The cold oil is thrown onto the reduction gears, falling from there onto a large mesh screen, covering the entire oil pan.

Only through elaborate means has it been possible heretofore to supply the pilot with a reliable method of indicating when a certain specified level of oil in the oil pan had been reached. On the front gear cover of the Thomas engines is mounted a pressure relief valve, connected to the oil cooling line, which creates a pressure of 10 pounds, which is read on a gauge in the cockpit. As long as the gauge registers pressure, the pilot knows that the pan is supplied with lubricant. As the oil reaches the two gallon level, to which the suction of the circulating pump is connected, the pressure begins to drop slowly. After the oil has ceased to flow through the cooling tubes, there are left in the pan two gallons, a safe margin upon which to operate.

STARTING EQUIPMENT

To enter into a discussion of the merits of a starter on an airplane engine is of little moment. The necessity for a starting equipment as an integral part of the engine must be recognized. It only remains to decide upon the type of starter to use and the position on the engine that it shall occupy. The Thomas engineers selected the Christensen starter as the one best adapted to their purposes. It's low weight, 40 pounds complete, and its compactness make it particularly suitable.

Until electric starters and batteries have undergone considerably more development they cannot hope to compete.

CARBURETOR POSITION AND FUEL SYSTEM

The placing of the carburetor between the two banks of cylinders is the only logical solution of good carburetion. It becomes a simple matter to obtain mixtures qualitatively and quantitatively the same for all cylinders. In connection with a gasoline pump driven directly by the engine, the low position of a the carburetor ceases to be a drawback from the standpoint of fuel supply. A gear pump drawing it in the tanks in the body forces gasoline to the carburetor. A pressure relief valve maintains the few pounds' requisite pressure in the line, while returning the surplus gasoline by gravity to the main tanks. This system permits the placing of tanks in any desired position in the body, independent of the carburetor. Furthermore, its reliability is that of a main oil pressure pump, because it is made up of the same simple units and driven by the same gear. It will be readily admitted that there is no occasion for a reliability of the fuel supply system greater than that of the lubrication system.

MAGNETO POSITION AND DRIVE

Very little need be said on this point. The two magnetos comprise two totally independent systems, even in their drive inasmuch as each magneto is driven by its own spur gear, shaft and couplings. It will be noted that the position of the magnetos together on a bracket of the timing gear cover makes it an easy task to couple together their respective spark levers and to synchronize them. Again, inspection from the cockpit becomes a simple matter.

EXHAUST SYSTEM

The tendency of the times in the matter of handling the products of combustion is toward the elimination of open exhausts. Because of the fact that the exhaust ports of the two banks of cylinders of the Thomas engine face each other, provision can be made equally well for mufflers, or for plain exhaust headers leading back over the body or for exhaust stacks leading straight upward over the top plane in the German fashion.

CONFERRING SIMPLICITY AND RELIABILITY

A glance at the Thomas engine will reveal one striking feature—namely, its simplicity. The engine is divided throughout into simple accessible and easily dissembled units. Whatever was not straightforward and clean cut was discarded as containing certain hidden elements of unreliability. The simplest elements into which an engine can be divided are none too simple at best. In the firm belief that reliability goes hand in hand with simplicity, the Thomas engineers have made these qualities the keynote of their philosophy of design.

Course in Aerodynamics and Airplane Design*

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and

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INTRODUCTION

The outline of the work in Part II has already been given in the introduction to Part I, and will be closely adhered to. The general problems of airplane design, as applicable to all types, will be adequately treated. The Course will include one section devoted to the study of the pursuit type and the twin-engine machine, but a very much closer study will be made of an advanced school machine. A design of such a machine will be carried out in accordance with the Army Specification, No. 1001. It is thought that a close study of a comparatively simple standard type of machine is the best foundation for work on more difficult machines. The design will be complete in so far as possible under the restrictions of space for detailed drawings.

PART II—SECTION 1

Classification of Main Data for Modern Airplanes; Unarmed Land Reconnaissance Machines; Land Training Machines

The Army Classification

Constructors in America have hitherto mainly developed one type of airplane, the tractor biplane reconnaissance machine. But with the rapid development of military aeronautics, airplanes are evolving into distinct classes, just as the component vessels of a fleet. The memorandum on "Military Airplanes," prepared by the office of the Aviation Section of the Signal Corps, offers the most authoritative classification, and one which constructors must of necessity follow very closely. It suggests six distinct types, which we shall study as closely as possible, within the limits of data held confidential by manufacturers. (I) Land Reconnaissance Machine, used when there are no enemy airplanes, (II) Land Primary School Machine, (III) Land Advanced School Machine, (IV) Land Gun Carrying Machine, (V) All-round Twin-engined, Land or Water, (VI) Land Pursuit Type.

Unarmed Land Reconnaissance Machine

For this machine, the memorandum gives the following figures:

TABLE 1

	Unarmed Land Reconnaissance Machine
Horsepower	130
Pusher or tractor	tractor
Number of men	2
Military load, pounds	475
Fuel load, pounds	450
Miles radius of action, full power	417
Climb in 10 minutes, feet	3,400
High speed, miles per hour	82
Low speed, miles per hour	40
Factor of safety	7
Percentage made in war	2

(Gross load is well over 2,500 pounds for this type.)

The memorandum deals very unfavorably with this type of machine, which forms, as we have said, an important part of American construction. It is said to be a false development, suitable only for use against an enemy who has no airplanes. Possibly useful for long-range reconnaissance, it will be outmatched in warfare by the armed "pursuit" type and the large armed twin-engine machine. For short ranges the pursuit type will surpass it, for long ranges the larger machine may be not quite so rapid, but will have a greater radius of action. A careful study of these views would lead one to believe them correct and in accordance with developments abroad.

Analysis of Main Data for Representative Unarmed Reconnaissance Biplanes Over 2500 Pounds Gross Weight

In Table 2 are given the main dimensions and performances of a number of representative machines. Such analysis and the empirical rules to be derived from it are invaluable in the preliminary stages of a design, and enable the designer to avoid misleading rough estimates of weights and dimensions.

TABLE 2

MAIN DATA FOR TWO-SEATER TRACTOR BIPLANES OF THE UNARMED RECONNAISSANCE TYPE OVER 2,500 POUNDS IN WEIGHT. RECENT EXAMPLES OF CONSTRUCTION

Machine	Standard H-3	Curtiss R-4	Wright-Martin V	Sturtevant S	Wright-Martin R
Engine	Hall Scott A-7	Curtiss	Hispano-Suiza	Sturtevant	Hall Scott A-5a
Horsepower	125	200	150	140	150
Number of cylinders	6	8	8	8	6
Revolutions per min	1,350	1,400	1,450	2,000	1,375
Gasoline tank capacity	63 gallons	100 gallons			70 gallons
Endurance in hours	6	3.42	appr. 6	4.5	4.84
Maximum speed, miles per hour	84	90		86	86
Minimum speed, miles per hour	40	48		42	47
Climb in 10 minutes, feet	4,400	4,000		3,500	3,500
Propeller diameter (two blades)	9		8' 4"		8' 6"
Weight loaded, pounds	3,300	3,247	2,310	2,550	2,880
Weight bare, pounds	2,500	2,225	1,125	1,850	1,995
Useful load, pounds	800	1,020	805	700	883
Per cent, useful load	24.2	31.4	14.2	27.4	34.3
Weight per horsepower in pounds	24.4	16.21	15.86	18.2	19.1
Weight per square foot wing area in pounds	6.20	6.42	5.36	4.64	[illegible]
Overall length	27' 0"	29' 0"	27' 2"	27' 6"	26' 8"
Mean span of wing/length	1.41	1.49	1.37	1.5	1.04
Wing section	R.A.F. 6	R.A.F. 6	Vaught 4	R.A.F. 6	
Upper span	40' 1"	48' 4½"	39' 8½"	48' 0"	50' 8"
Upper chord	5' 6"	6' 3"	7' 0"	6' 1"	5' 6"
Upper aspect ratio	8.2	7.75	5.85	7.95	9.25
Lower span	40' 1"	38' 5½"	39' 8½"	39' 6"	30' 10"
Lower chord	6' 6"	6' 3"	5' 8"	6' 4"	5' 8"
Lower aspect ratio	6.2	6.15	6.95	6.23	6.6
Gap	5' 6"	6' 2"	7' 7"	6' 3"	6' 0"
Gap/lower chord	1.00	0.98	0.98	1.00	1.09
Total area of wings, including ailerons, in square feet	432	503	430	540	475
Area of rudder in square feet	10	16.5	12.5 appr.	15	8.7
Area of vertical fin in square feet	5	7	8 appr.		7.3
Area of elevator in square feet	23	27.5		24	
Area of stabilizer in square feet	32	48.5	81.2 (elevator and stabilizer)	28	53.2 (elevator and stabilizer)
Ailerons upper wing	31	33.8	32.8	30	48
Ailerons lower wing	31	20.5	32.8	30	
Type of fuselage	Rectangular	Rectangular	Rectangular	Triangular	
Dihedral	3°	3°	1° 18'	2°	1°
Stagger	10°	5° appr.	1 ft	None	20.4% chord length
Sweepback	10°	None	None	None	None

NOTE.—All data submitted is in accordance with manufacturers' reports.

* This Course commenced in the August 1, 1916 issue of AVIATION AND AERONAUTICAL ENGINEERING will be completed in 24 issues.

Average Values for Machines Over 2500 Pounds Weight

This group is composed of excellent, controllable machines very similar in character. It is therefore possible to draw some fairly definite conclusions.

(a) Average gross weight, 2957 pounds.

(b) Average wing area, 493 square feet.

(c) Average horsepower, 155. The latter figure is considerably increased by the inclusion of the Curtiss R-4 with its 200 horsepower engine. There is a tendency to give higher power in this class, with correspondingly better performances.

(d) Average endurance, 5.65 hours. This figure is probably a very fair value of the endurance possible if good climb is to be maintained. It should be noted that it would be possible to take up much more fuel, and not decrease the speed, in fact, to increase it slightly. At the same time, minimum speed would be increased.

(e) Average weight per horsepower, 18.4 pounds. The Curtiss lowers this average value, and is an indication of what will follow when lighter new engines, such as the new Thomas and Sturtevant, enter into construction.

(f) Average weight per square foot of wing area, 5.99 pounds.

(g) Average maximum speed, 86.50 miles per hour.
Average minimum speed, 45.75 miles per hour.
Average climb in 10 minutes, 3666 feet.

The number of machines considered is too small for curves to be plotted, but it is interesting to see how in diminishing the weight per horsepower from 24.2 pounds to 16.21 pounds the maximum speed increases from 84 to 90 miles per hour, while the low Sturtevant wing loading gives a landing speed of 42 miles per hour as compared with the Curtiss of 50 miles per hour.

(h) Average of ratios of $\frac{\text{mean span}}{\text{overall length}} = 1.51$

This is an important point to be considered in the design of a machine. As we shall see later in considering longitudinal stability, it is quite possible to secure adequate static stability by using a short body with a large tail surface placed at a negative angle. But an excessively short body, although it means saving in weight, may fail to give dynamic stability, due to lack of damping. At this stage of the science, we can only fix on a length for the body by taking average values such as the above.

(i) Average aspect ratio upper wing, 7.80.
Average aspect ratio lower wing, 6.76.

There seems in the light of these figures no reason why an aspect ratio of 7.5 for the upper span, and 7.0 for the lower should not be successfully employed.

(j) Gap/chord ratio is practically 1.00 in every case. Without undue conservatism, it would appear that for machines of this size, the increased structural weight of a larger gap/chord ratio is prohibitive, whereas in smaller machines with smaller chord, much greater values might be employed to advantage.

The dimensions of control and stabilizing surfaces present an exceedingly complex problem, so many factors being involved. They will be carefully studied in our design, but in the preliminary stages some of the following empirical relationships may be useful.

(k) Aileron or wing flap area. The dimensions of these will depend on the area of the wings whose rolling moment it may be necessary to overcome, on the weight and lateral radius of gyration of the machine and on the span of the wings which gives the moment arm of the ailerons. These factors are too complex, however, and at present the following formula offers a fairly satisfactory standard of comparison:

$(S_1a_1 + S_2a_2) = CA$, where A = area of wings, S_1 and S_2 = spans of upper and lower wings, a_1 and a_2 = aileron areas on upper and lower wings. C = a constant. Where C is large there is powerful lateral control, where C is small there is weak lateral control. The values for the above five machines are as follows:

Standard H-3	Curtiss R-4	Wright Martin V	Sturtevant S	Wright Martin R
4.65	4.80	5.95	6.50	5.14

Too powerful lateral controls present difficulties in handling just as too weak controls. The average value of $C = 5.38$ might be at least some guide.

(l) For the horizontal elevator and stabilizer, the following very rough formula is sometimes employed in preliminary work, based on ideas similar to those enunciated in the previous paragraph:

$d = \frac{QL}{AC}$, where d = some constant, Q = area of elevator and stabilizer, L = overall length, A = area of wings and C = mean chord.

The following constants hold for our five well controlled machines:

Standard H-3	Curtiss R-4	Wright Martin V	Sturtevant S	Wright Martin R
.420	[illegible]	.505	.410	[illegible]

These constants are fairly close together, with an average value of .507. A big value of d means powerful control. Without further analysis, it is seen from Table 1 that the stabilizer is much between 20 to 50 per cent larger than the elevator.

(m) Similarly for vertical surfaces, if $f = \frac{VL}{AS}$, where f = constant, V = vertical area of rudder and fin, L = length, A = area of wings and s = mean span of wings, we find:

Standard H-3	Curtiss R-4	Wright Martin V	Sturtevant S	Wright Martin R
.019	[illegible]	.027	[illegible]	[illegible]

Average value [illegible]

We shall discuss the problem of vertical fin and rudder area more closely later.

Primary and Advanced Training Airplanes

In the training of military pilots similar methods are now employed in the majority of schools, and there are two distinct stages, "primary" and "advanced" training.

On the primary machine, the aviator obtains his first certificate, and the requirements of this type tend toward a steady, slow type of machine, in which it is easy to acquire confidence. The advanced training machine is scarcely distinguishable from the land reconnaissance machine, although it is somewhat slower. In the memorandum on Military Airplanes, the following suggestions are made for these two types, which are of obvious and permanent utility:

TABLE 1

	Land Primary School can also be used for field artillery fire control	Land Advanced School can possibly be used for mountain and forest tactical reconnaissance
Horsepower	80	100
Pusher or tractor	Tractor	Tractor
Number of men	[illegible]	2
Military load, pounds	[illegible]	400
Fuel load, pounds	[illegible]	240
Miles radius of action, full power	[illegible]	300
Climb, feet in 10 minutes	2 000	3 000
High speed, miles per hour	[illegible]	75
Low speed, miles per hour	[illegible]	[illegible]
Factor of safety	[illegible]	7
Percentage used in war	[illegible]	28

In designing training machines, the constructor has the advantage of complete specifications issued by the Signal Corps (Aeronautical Specifications, Nos. 1001 and 1002). These specifications are readily obtainable, but some of the main points are set forth here, as they will be applicable to our design of a standard machine, and must be constantly kept in mind by the designer.

IMPORTANT POINTS IN SPECIFICATIONS NOS. 1001 AND 1002 FOR MILITARY TRAINING AIRPLANES

Primary	*Advanced*
1. Tractor biplane, useful load:	
(a) Pilot and passenger 330 pounds. Three hours	(a) Pilot and passenger 330 pounds. Four hours
(b) Gasolene, oil and water	(b) Gasolene, oil and water

2. Curtiss eight cylinder OX-2, 90 horsepower at 1400 revolutions per minute, or an approved American made engine between 70 and 90 horsepower for the primary, and between 90 and 110 horsepower for the advanced.

3. Minimum speed 37 miles per hour. Maximum speed not less than 66 miles per hour	Minimum speed, 43 miles per hour. Maximum speed not less than 75 miles per hour

MODERN AMERICAN TWO-PLACE TRACTORS

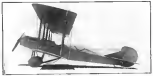
These Photographs Show Representative Two-Seater Tractor Biplanes of the Unarmed Reconnaissance Type, Weighing Over 2,500 Pounds


The Wright-Martin Model R Tractor


Sturtevant S Tractor


Model V Wright-Martin Tractor


The Standard Model H-3 Tractor


The Curtiss R-4 Military Tractor

4 Fully loaded machine must attain an altitude of 10 000 feet in

Two hours.	75 minutes.

5 Climb in 10 minutes shall be not less than

2600 feet	3000 feet

6. Celerity of response to control, the proper degree of symmetric and assymmetric stability (static and dynamic) steadiness in disturbed air etc Satisfactory manoeuvering on the ground

7 Both the dual Curtiss (shoulder or chest yoke) and dual Deperdussin types of control ready for installation in cockpits

8 Factors of safety

(a) Main plane structure Conditions assumed

(1) Load as above

(2) Angle of incidence of mean chord of main planes that of maximum lift coefficient

(3) Air speed that normally corresponding to the above load and angle of incidence for the [illegible] effective surface area

Factor of safety not less than 7 5

(b) Body and tail structure

(1) Air speed 100 miles per hour

(2) Angle of incidence of fixed horizontal tail surface minus 6 degrees elevator surface minus 20 degrees

Factor of safety not less than 2.5

9 A complete outfit of instruments tools pressure gauges etc is specified.

10 Three wheel type landing gear the third wheel being 20 x 4 inches just in rear of the plane of rotation of the propeller normally not touching the ground but designed to touch the ground when the main chord of the main planes is horizontal Main wheels 26 x 4 inch tires and [illegible] x 1½ inch hubs with spokes | Landing gear of two wheel type Wheels 26 x 4 inch tires and [illegible] x 1½ inch hubs

11 Body shall be of one part not the jointed tail type All turnbuckles in the body wiring to be readily accessible In the skin wiring they should be near the upper longerons The wing spar fittings on the body to which the lower planes are attached shall be tied together across through the body by steel tubing The interior of the body shall be so constructed as to permit thorough inspection of all wiring control leads etc As far as practicable all leads shall be direct

12. The design and mounting of the tail skid and vertical rudder shall be such as to prevent injury to the vertical rudder in case of failure of the tail skid

13 The number of different sizes of turnbuckles shall be reduced to the minimum Pulleys pins bolts, turnbuckles etc drilled for safetying Safety wire shall be of No 18 gage copper wire

14 Satisfactory fields of vision

15 Seats in tandem padded cockpits, safety belts.

16 Housing around power plant readily detachable Convenient access to all parts of the engine which may require adjustment or inspection.

17 Radiator proof against vibration

18. Gravity feed throughout preferred A positive and reliable system of pumping may be used, in which case a gravity feed tank holding at least forty minutes supply to be embodied

19 Upper plane to extend beyond the lower plane laterally by an amount approximately equal to the chord Lateral control to be by means of trailing edge flaps on the upper plane only

20 Stranded steel cable shall be used for all tension members which are readily accessible for adjustment and for all control leads. Structural tension members shall be of hard cable and control leads shall be used for terminals of hard single strand wire No spliced terminals in hard cable will be accepted All cables which are members of the wing structure and normally under tensile load in flight shall be in duplicate and made independent between fittings Satisfactory provision for convenient and thorough inspection of control cables and pulleys and vital structural members In the internal wing bracing the compression members carrying the drag of the wings shall be separate wooden struts and not wing ribs Rib webs shall be reinforced between lightening holes to strengthen them in longitudinal shear

The above specification not only provides an excellent guide for the design of the school machine, but is also a guide to the performance which may be expected of this type. A machine might be perfectly acceptable, however, even if it did not adhere rigidly to the above specification, provided its main requirements were successfully carried out Particularly is this true as regards the engine power

Data for a Typical School Machine Under 2000 Pounds in Weight

The Curtiss JN4-B, for which full data is supplied by the manufacturer is a good example of this type and in default of a classification such as that of Table 2 should prove a reliable guide in preliminary design

CURTISS JN 4 B

Engine Curtiss OX horsepower, 90, cylinders 8, revolutions per minutes, 1400, weight per rated horsepower 4 02 pounds, bore and stroke 4 x 5 inches, fuel consumption per hour, 9 gallons, fuel tank capacity 20 gallons oil capacity 4 gallons fuel consumption per brake horsepower per hour 0.[illegible] pounds, oil consumption per brake horsepower per hour 0.030 pounds

Maximum speed 75 miles per hour minimum speed 43 miles per hour, climbing speed 3000 feet in 10 minutes

Net weight, machine empty 1320 pounds gross weight of machine and useful load (fuel for 4½ hours) 1905 pounds distributed as follows 225 pounds fuel 30 pounds oil 165 pounds pilot 165 pounds passenger Total 585 pounds Percentage useful load, 30.7 per cent

Total supporting surface [illegible] square feet loading per brake horsepower 21.16 pounds loading per square foot of supporting surface [illegible] pounds

Wing section Eiffel 36 upper span, 43 feet 7⅜ inches upper chord 4 feet 11½ inches lower span 33 feet 11¼ inches lower chord 4 feet 11½ inches gap 5 feet 2 3/16 inches overall length of machine 27 feet 4 inches overall height, 9 feet 10½ inches ratio of mean span to overall length 1:4.

Dihedral 2° degrees sweepback 0 degrees stagger 12 5-16 inches

Control surfaces—Ailerons (upper wing) [illegible] square feet constant in formula [illegible] Horizontal stabilizer 28.7 square feet elevator 22 0 square feet Constant in formula $d = \frac{1 l}{A C} = 0$ [illegible] Rudder 12.00 square feet Vertical fin [illegible] square feet Constant in formula $f = \frac{1 l}{18} f$ 0.29

Photographs and Drawings

Considerations of space do not permit inclusions of drawings of these types The accompanying photographs are representative Details of construction and drawings will be fully developed in our design in subsequent sections, and drawings of one or two representative machines will precede this design

In the ensuing section, we shall study the pursuit type, the Twin Engine Machine, and the armed reconnaissance type

References for Part II, Section 1

Memorandum on Military Airplanes Prepared in the Office of the Officer in Charge of the Aviation Section Signal Corps U S A AVIATION AND AERONAUTICAL ENGINEERING September 15 1916

Aeronautics by J C Hunsaker in the *Mechanical Engineers Handbook*

Aeronautical Patents

Copies of these patents may be obtained for five cents each by addressing the "Commissioner of Patents Washington, D C"

ISSUED JANUARY 30 1917

1 213 909 Filed March 11, 1916 To Adolf Frank Russ, Pittsburgh Pa Airplane wing

1 213 945 Filed March 18 1916 To Joseph W Lechowsky Webb City Mo Toy helicopter

ISSUED FEBRUARY 6 1917

1 214 336 Filed April 27 1911 To Edson F Gallaudet Norwich, Conn An airplane

1 215 226 Filed June 30, 1916 To George M Wanee Oakland Cal Flying machine

1 215 295 Filed March 14, 1916 To Harold MacKay Thetford Center Vt An airplane

1 214 592 Filed August 14 1916 To Armando Iten New York N Y A kite

1 214 612 Filed March 29 1915 To Neil Ferry Hardisty Alberta, Canada Airplane stabilizer or control

1 214 835 Filed July 12 1916 To John Thomas Simpson Newark, N J A flying machine

1 214 901 Filed March 25 1915 To Joseph S Dale Jr New York, N Y Stabilizer for flying machines

1 214 955, Filed March 27 1916. To William C Robinson Grinnell, Iowa. Airplane rib

ISSUED FEBRUARY 13 1917

1 215,842 Filed April 21 1916 To Chas. Osborn Everett Wash. Toy flier

1 215 466. Filed September 7 1915 To John William Curtis Baltimore Md An airplane

Permanent Aircraft Manufacturers' Association Formed

At a meeting of aircraft manufacturers held Thursday afternoon, February 15, 1917, the Aircraft Manufacturers' Association completed its organization. The organization will be made up entirely of manufacturers of complete airplanes and dirigibles

The following officers were elected at the meeting held Thursday

President Harry Bowers Mingle, president, Standard Aero Corporation

Vice-President, Glen H Martin, vice president, Wright Martin Aircraft Corporation.

Secretary-Treasurer, Inglis M Uppercu president, Aeromarine Plane and Motor Company

This is the organization which offered the support and cooperation of its members to President Wilson

The airplane manufacturers who are the incorporators of the association are as follows

Aeromarine Plane & Motor Company John D Cooper Aeroplane Company L W F Engineering Company, Standard Aero Corporation, Sturtevant Aeroplane Company, S S. Pierce Aero Corporation, Thomas-Morse Aircraft Corporation Witteman-Lewis Aircraft Company Wright Martin Aircraft Corporation

The following are the purposes for which the organization was formed

(a) To provide an organization for the interchange of ideas concerning aeronautics of every kind and description, for the benefit of the members and the public at large

(b) To instil and foster in its membership a spirit of patriotism and love for their country, and to provide an organization for the purpose of potently, ably and efficiently assisting the Government of the United States, or any branch thereof, when public welfare requires.

(c) To encourage the growth and understanding of all things aeronautical and any new and useful devices therein, or auxiliary thereto, and to effect a standardization thereof

(d) For the purposes of fostering interest in things aeronautical, to arrange, manage, regulate, govern, control, give and have charge of all kinds of exhibitions, displays, expositions and shows

(e) To acquire and dispose of by any and all lawful means, such property as the purposes of the corporation shall require for the benefit, but not for the pecuniary profit, of its members, subject always to such limitations as by law prescribed

Robert Glendinning Commissioned a Reserve Major

Robert Glendinning, the Philadelphia banker and aviator recently "reported" to the Aviation Section, Signal Corps, offering his services in any way that that department might find useful. He will be commissioned as a major in the Officers Reserve Corps and assigned to the new aviation school which is to be established in Philadelphia

Army Receives Airplanes

A [illegible] speed scout capable of flying 120 miles an hour and [illegible] reconnaissance airplanes arrived at the Army aviation school at San Diego, Cal., on January 31 The "baby scout" the fastest plane yet received at the school, has a wing spread of less than 25 feet, and it is claimed can climb 10,000 feet in ten minutes Two pursuit triplanes, which are expected to develop a speed of 125 miles an hour, are expected soon. The triplanes, the first of this type added to the equipment of the aviation school, are said to compare favorably with the best machines now used by England, France, and Germany

The motor truck transportation train to be used by the First Aviation Squadron, now being organized at San Antonio, Texas was received on February 8 The train consists of twenty-two powerful trucks The trucks were unloaded and driven to the aviation post north of Fort Sam Houston Two machine shop trucks are expected soon

All the airplanes have not been received by the squadron Under the regulation reorganizing the aviation service, each squadron is to be equipped with thirty six airplanes, of which twelve are for active service and twenty-four for the reserve

Instruction of aviation officers in the use of the Deperdussin control is in progress at the Post. All of the new machines are to be equipped with this new control All pilots in the Army will be taught the use of the new appliance in order that they may be qualified to operate the new 200 horsepower machines

AIRPLANE MANUFACTURERS IN CONVENTION AT HOTEL MANHATTAN, N. Y

Sitting, left to right A. H Flint, S D. Waldon, F Gates Porter, H. B Mingle, President; J D Cooper, F L. Morse, Inglis Moore Uppercu, and J P. Tarbox Standing, left to right: Capt H M Wald, Tom W Benoist, D L Meenan, Jr, W E Doherty F A Fawcett J Lansing Callan, Frederick C Hild, Charles A Herrmann S S Breese, A S Heinrich, C F Van Husan, and W M Blair

Pensacola News and Notes

General preparations for eventualities in the international crisis are reflected in the activity of the aeronautic station, and strict censorship is being enforced. No one is permitted to enter the enclosure except on business, and then only with passports.

Aside from the necessary safeguards thrown around the work at the station, instruction and routine work proceed as usual, and the arrival and testing of new machines occupies first place. Boats for scouting in the gulf have arrived and afford ample opportunity for speed maneuvers impossible with the larger craft heretofore used.

In acceptance tests for the new Curtiss, 83-A, 200 horse power machine, Lieutenant Phillips Rader established a new altitude record for hydroaeroplane with passenger in ascending to a height of 10,500 feet, remaining aloft four hours. Other regulation examinations were conducted by Lieutenant Rader, and the machine has finally been accepted, being the largest in operation here.

Before resuming his duties at the school at Miami, Lieutenant Rader conducted some tests for the government with the Gallaudet, the newest arrival at the station.

While not directly connected with the aeronautic station, the Pensacola yard has been selected as one of the five points in the country for the establishment of naval training stations, to be opened on June 11 and continuing for one month. It is considered particularly significant, however, that the placing of one of the stations at Pensacola opens the possibility of development of civilian training for aeronautics.

The arrival of the cruiser *Columbia*, monitors *Ozark*, *Bushnell* and *McDonough*, and submarines *L-1*, *L-2*, *L-3*, *L-9*, *L-10* and *L-11*, together with the destroyer *Rowan*, added a great impetus to the work of the aeronautic station, and maneuvers are being held in connection with the various vessels of the flotilla. Late in February, the *Tallahassee* and six K-Boats will join those already here, the entire number to remain in port until April 14, for spring practice.

By far the most successful balloon flight ever conducted by officers of the aeronautic station was made recently under the supervision of Lieutenant Commander F. L. McCrory, with Captain Geiger of the Marine Corps as passenger. The craft was released late one afternoon for an all night flight, and under the prevailing westerly winds, landed the next morning at Darien, Ga., on the Atlantic Coast. The trip was made much faster than the balloonists anticipated, and they were forced to descend quickly to avoid being taken out over the ocean.

Lieutenant W. M. McIlvain of the Marine Corps had an unusual experience while making a flight recently, when a heavy fog blew in suddenly from the gulf, enveloping practically the entire Gulf and Atlantic coast. At the time he was over Pensacola bay. He landed immediately because of trouble with his carburetor. Unable again to start the engine he drifted about without sighting, and when upon his failure to return speed boats were sent in search, he could not be found. After being out nine hours he was picked up and returned to the station.

Students of Four Colleges Wish to Learn Aviation

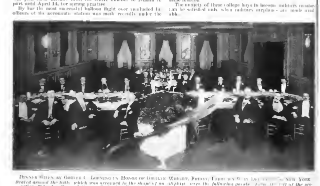
Graduates and students from Harvard, Yale, Columbia and the University of Pennsylvania are said to have requested the assistance of the Aero Club of America in the formation of aeroplane corps in their universities.

Twenty-five Yale men have announced their intention of becoming aviators, and at Harvard, which has already two licensed air pilots, there are thirty more candidates.

The students hope that matters may be so arranged that they will be able to get their instruction on the aviation fields about Boston, and will not have to discontinue the rest of their studies in order to learn to fly.

Columbia men have applied at the Aero Club for advice on how to form a Columbia Aeroplane Squadron, and a group of the alumni of the University of Pennsylvania called on the same mission.

The anxiety of these college boys to become military aviators can be satisfied only when military airplanes are made available.



DINNER GIVEN BY GROVER C. LOENING IN HONOR OF ORVILLE WRIGHT, FRIDAY, FEBRUARY 9, IN DETROIT ... NEW YORK. *Seated around the table which was arranged in the shape of an airplane were the following guests from the left of the propeller:* Brigadier General George O. Squier; Naval Constructor George C. Westervelt; Captain Edmund ... ; Thomas ... ; Edson F. Gallaudet; Naval Constructor Jerome C. Hunsaker; ... ; Orville Wright (in the cockpit); G. C. Whiting; Alexander Klemin; C. M. Vought; T. H. Huff; Captain Henry H. Harris; H. N. Pope; Captain Joseph E. Carberry; Grover C. Loening (in the cockpit); ... ; ... ; Ralph Upson; Captain H. ... ; Martin Church; ... ; ... ; L. D. Gardner; Henry Souther; ... ; ... Morton

Developments in Wright Patent Situation

The National Advisory Committee for Aeronautics, under the direction of Dr. Charles D. Walcott of the Smithsonian Institution, has recommended to the Secretary of the Navy that the Wright patents be purchased by the Government. At Secretary Daniels's request, a conference was arranged with the Wright-Martin Aircraft Corporation officials, and the purchase price discussed.

On February 6, the following amendment to the Naval Appropriations Bill was introduced by Congressman Lemuel P. Padgett:

"To enable the Secretary of War and the Secretary of the Navy to secure by purchase, condemnation, donation or otherwise such basic patent or patents as he may consider necessary to the manufacture and development of aircraft in the United States and its dependencies for governmental and civil purposes, under such regulations as the Secretary of War and the Secretary of the Navy may prescribe, $1,000,000. *Provided* That such arrangement may be made in relation to the control of any basic patent connected with the manufacture and development of aircraft in the United States, as in the judgment of the Secretary of War and the Secretary of the Navy will be of the greatest advantage to the Government and the development of the industry."

With the amendment, Mr. Padgett submitted a letter from Secretary Daniels which stated that President Wilson had approved the plan of purchase and recommended the passage of the bill. Letters were also submitted from several aircraft manufacturers giving their views on the Wright patent situation.

On February 13, the amendment was passed with the following important amendment: "*Provided further* That in the event there shall be pending in court litigation involving the validity of said patent or patents bond, with good and approved security in an amount sufficient to indemnify the United States, shall be required, payable to the United States, conditioned to repay to the United States the amount paid for said patent or patents in the event said patent or patents are finally adjudged invalid."

During the discussion of the amendment, the words "civil purposes" were especially referred to in an attempt to determine the exact meaning of this part of the measure. The bill will now come before the Senate for action.

IT IS REPORTED THAT—

WILLIAM B. JONES of Wilkinsburg, Pa., the automobile race driver, has taken up the study of aviation and has bought a training machine.

CHARLES HERZOG, a professional baseball player and third baseman of the New York "Giants," is studying aviation in Florida, and as soon as he has completed his preliminary training will apply for a commission as a Reserve Military Aviator.

Bert Kenyon who is interested with Jewell and Ted Clark of Grand Rapids, Mich., in perfecting an airplane model, recently went to Washington to obtain data to make the machine conform to the United States military requirements. They are preparing a plant to manufacture this airplane and strong inducements have been made to locate the factory at Muskegon.

The Hayward (Cal.) Chamber of Commerce will offer land in that city north of the Foothill Boulevard to the United States Government as a site for the proposed aviation station.

The Davenport Aviation School, near New Orleans, is awaiting the arrival of a flying boat and a tractor biplane. The company operating it expects to build several types of flying boats.

Adjutant Bert Hall of Bugle Pass, Texas, who is a member of the French flying corps, has been transferred from France to Rumania. It is said he is the first American aviator to be sent to the eastern front.

Lieutenant Harry Johnson, U. S. A., who recently lost his right leg at Columbus, N. M., has been discharged from the hospital. He is planning to go to the Philippines, Japan and China for the winter, where he will continue to fly.

Carl Wake, an inventor of Walla Walla, Wash., is constructing a military biplane with a wing spread of 36 feet. It will use a 70 horsepower engine, and is expected to make 85 miles an hour.

Russel and Willur Whiteman of Pasadena, Cal., have constructed and tested a dirigible with a new type control said to be more efficient than that employed on the German Zeppelins. They are now at work on a semi model dirigible.

J. Lansing Callan, until recently instructing Italian aviators how to use Curtiss machines, has returned to the United States, and will be one of the instructors at the aviation school for Army fliers at Miami, Fla.

Lawrence Sperry has submitted a plan to the War Department for the probationary enrollment of women aviators in the Army Aviation Reserve Corps for such service back of the lines as watching for enemy aircraft and submarine mines, and in guarding cities and harbors.

Frank E. Chaney, a former parachute jumper, who later became an aviator and saw service with the British on the Somme front, has returned to his former home, Rochester, N. Y. In spite of many exciting aerial encounters, the only injury he received was from bayonet wounds after his machine was disabled and he sprawled down in the midst of a charge.

Miss D. F. Brown, an English aviator, who has been flying in France, has arrived in this country, where she will spend a short vacation.

Lieutenant William N. Heath, Jr., of the United States Volunteer Aero Corps at Old Point Comfort, Va., was recently injured when the gasoline tank on his seaplane exploded. The machine is said to have been totally wrecked.

Richard C. Nygren of New Britain, Conn., has designed a new military tractor biplane. He has completed a working model, and has commenced on the construction of a large machine.

Roger Amory, of the class of Harvard, 1910, the chairman of last year's Undergraduate Aero Training Corps, recently addressed the Harvard men who desire to enter the government's aviation schools next summer.

THE CANADIAN JN-4, BUILT IN TORONTO

The Ohio State University may establish a course in aeronautics in its engineering department.

The Pacific Aero Club has appointed a committee to start a campaign for raising funds for the permanent preservation of the Column of Progress on the Marina, which during the Exposition served as a monument to aviators.

Brigadier-General F. S. Strong, U. S. A., has been elected president of the Aero Club of Hawaii in place of Brigadier-General Robert K. Evans, resigned. The club now has 333 members.

Charles H. Day, chief engineer and designer of the Standard Aero Corporation, Plainfield, N. J., spoke at the recent meeting of the Standard Aero Club.

Al Johnson, for nine months representative of the Curtiss Company in Europe, is now acting as instructor at the U. S. Army Aviation School at Chicago. He recently married Miss Lorraine Carner of Buffalo, N. Y.

Howard Huntington has resigned as vice-president and consulting engineer of the American Aircraft Company.

The Aero Club of Michigan is planning to organize an aerial reserve company for Detroit, according to an announcement made by S. D. Walton, one of the directors.

The Muzzy-Lyon Company, Ltd., has completed arrangements with the Duesenberg Motor Company to supply the company with the bearings to be used in the airplane engines it is now building for the government.

The Fulton Company of Knoxville, Tenn., has been awarded the contract to supply thermostats to regulate the temperature of the gasoline engines to be used on United States Government airplanes.

New Type German Airplanes

According to Jean Lagorgette, of *L'Aerophile*, the Germans have within the last few months come to realize the importance of overwhelming speed, such as can only be obtained by small pursuit machines in deciding air battles, and many new types of German pursuit machines have recently appeared. The production of these planes is the more remarkable because they are often made in factories which up to the present time have been confining their output to "slow-sloggers."

On October 26 last the first Halberstadt scout was shot down. The machine is a two-seater, and its main dimensions are: span, 30 feet; chord, 5 feet; gap, 3 feet 8 inches; stagger, 1 foot 11 inches; length, 20 feet. It is engined with a 120 horsepower Argus; ailerons are on the upper planes only and the armament consists of a rapid fire gun which shoots through the propeller.

THE ROLAND

Just as all the early German war machines were called "Taubes," it seems likely that the later ones will be called "Whales" or "Walfisches," because of the large size of the front part of their bodies, which houses the heavy horsepower engines. The horsepower varies as a rule, from 160 to 220. A "Whale" of Roland manufacture was recently reconnoitred by French fighters. The figures on it are: Span 32 feet; chord, 4 feet 6 inches; gap, 4 feet 6 inches; engine 160 horsepower Mercedes. Ailerons are attached to the top planes. The upper planes are cut away above the body so as to give better field of observation and field of fire to pilot and observer. Windows in the sides of the body also serve to improve the observation field. The body is of the [illegible] type oval. The armament is a Lewis gun mounted on top of the upper plane. The landing chassis is fitted with a few hooks. The climb of this machine is said to be about 1000 m in 8 minutes.

THE [illegible]

The aviators who are fighting for the Allies have reported within the past few weeks that Germany has copied the [illegible] Spad which has been doing such good service for the French and English. In reality the German machine is a [illegible] Albatros, very different from anything that has come from the Albatros factory hitherto. The body of this machine is of a "whale" shaped. The Albatros has a generally round tail plane with a rudder well in front of the elevating planes. The general appearance of the machine closely resembles the British Ago type. The planes have the same chord and gap throughout their entire length and either one or two pairs of struts are used on either side of the body. The general arrangement of the body, tail and landing chassis follows Nieuport practice very closely.

THE NEW FOKKER

A new Fokker scout has recently put in its appearance on the German side of no-man's land. The body is of Nieuport type, the wings, which are cut out behind, are braced with two pairs of struts, and the landing gear is no longer of the M type, but has been simplified until the conventional V type is now in use.

Perhaps the most unusual feature of this new Fokker is the fact that ailerons are not used, but lateral stability is maintained by warping the wings.

The engine is an Oberusel (German Gnome), using the single valve arrangement. It is installed inside a circular cowl and turns a Garuda propeller. The machine gun shoots through the propeller.

Radio Telephoning from Airplane in Flight

The latest accomplishment of the North Island Military Aviation School at San Diego, Cal., is the successful installation of a radio telephonic outfit.

For the first time in the history of American aeronautics, radio telephone communication between a military airplane in flight and a land receiving station was established. The tests were a pronounced success, according to officials of the school.

Flying at an altitude of 800 feet in a tractor biplane piloted by Capt. Herbert Dargue, Capt. Culver succeeded in transmitting several verbal messages a distance of approximately three miles.

Within the next ten days Capt. Culver expects to have two aeroplanes flying miles apart conduct a conversation.

Miss Stinson Offers Her Services

Miss Katherine Stinson, who is giving exhibitions of fancy flying in Japan, has offered her services to the United States Government. Her cable, sent at the time of the break with Germany, read:

"Rumored war Germany. Offer services.

"KATHERINE STINSON."

Lee W. Oldfield to Build Airplane Engines

Minneapolis is to have an airplane engine plant that will begin business in a building that is expected to be the first unit of a group that will stand on the Minneapolis Industries Association's site in Northeast Minneapolis. Lee W. Oldfield, automobile engineer, 2431 Central Avenue, is to head the new company, which will be known as Oldfield Motors Corporation. It will make the Oldfield rotary airplane engine.

The building, for which Mr. Oldfield said plans now are being drawn, will cost $60,000. It is expected that the plant will be turning out product by June 15.

President Douglas A. Fiske of the Minneapolis Industries Association said last night that the company yesterday gave the Oldfield Motors Corporation an option on 400 feet of trackage on the industries site.

Post Office Investigates Chicago-New York Air Route

The Post Office Department is investigating the possibilities of establishing a regular airplane mail service between New York and Chicago. Expert aviators are alarmed over the plans, which, as announced, contemplate night flying between the two cities. The difficulties are sufficient in the present state of the art, they say, for such a flight in the day time, let alone night flying.

Discussing the proposal as an experienced aviator, Miss Ruth Law, who made the flight of 8 hours, 55 minutes and 35 seconds from Chicago to New York, said:

"I hope that Congress will appropriate the money, so that the actual possibilities of airplane mail service may be determined. I believe that such a service between New York and Chicago, although it would encounter many difficulties, could be made to work. I understand, however, that the plan proposed contemplates night flying, and I must criticize it in this point. The difficulties of maintaining a day service would be sufficient. Why increase them to the point of disaster by attempting a night service?

"I have done enough night flying to know what it is, and I can say emphatically that a night service between New York and Chicago at this time is not possible. The single question of emergency landings would present an insolvable problem. But if the flights were attempted in the day time with proper arrangements, I believe that the service might be developed to real utility."

Glenn Muffly, manager of the Muffly Motor Company, who is credited with having fostered this scheme and interested the Post Office authorities in the Chicago-New York service, states that he is willing to make one trip each way six days a week for $1,000 a day. In a letter to AVIATION AND AERONAUTICAL ENGINEERING, he writes:

"We have not yet made public all the figures. We will put through at least 15 complete sets of parts to start with and have nine machines and aviators ready to fly. The two greatest items of depreciation are on the motor and on landing [illegible].

"If we are able to cover operating expenses without paying interest on investment we will be satisfied, for the addition of more machines making more than one trip a day in each direction will cut the overhead cost per trip and make the profit possible. We will lease 28 emergency landing stations and own five regular stations. We will burn about $100 worth of gas per night in the signal lights and maintain five reserve machines and pilots in addition to the four that are in daily service.

"Building our own motors and machines we will be in position to keep our mechanics busy and to make changes as they are found advisable. We expect to thus develop a degree of reliability not yet attained in airplane or motor construction and provisions are made for every cause of delay imaginable. This is but the beginning of a great business and we are looking to ultimate success rather than present profits. It must not fail for lack of attention to detail."

The average life of an airplane in war time, according to *The Naval Flying Corps Monthly*, is three months, and England has at present 10,000 machines in the field.

The Twin-Engined A. E. G. Biplane

The Twin-Engined A. E. G. Biplane

The A. E. G. biplane is the only type of twin-engined machines at present used by the Germans, their early experiments with double-bodied biplanes having been abandoned, according to Jean Lagorelle in *L'Aerophile*. The A. E. G. is the product of the Allgemeine Elektrizitats Gesellschaft, or General Electric Company, whose equipment is now largely given over to the manufacture of aircraft.

BOTTOM VIEW OF THE A. E. G. TWIN-ENGINED BIPLANE

There is nothing really unusual about the machine except its size. It does not even show the usual German characteristics, and might easily be mistaken for the product of a French firm. The span of the upper wing was nearly 80 feet in the first machines built, but has recently been reduced to 62 feet in accordance with the tendency toward a reduction of size which all German machines have shown. The span of the lower wing is nearly equal to that of the upper and the chord is the same in each. The wings are slightly swept back, and there is also some dihedral, as will be seen from the figures. Ailerons are used on the upper wing only.

The overall length is 33 feet. The body is of rectangular section, the upper surface being horizontal in flight. The engines are mounted between the planes, the shafts being 13 feet apart. It is rather surprising to see that there is no attempt at encasing or stream-lining any part of the power plants. The tail is not in any way distinctive, having the usual triangular fin above the body and a triangular stabilizer.

The landing gear is somewhat unusual, consisting of four

SIDE VIEW OF THE A. E. G. TWIN-ENGINED BIPLANE

FRONT VIEW OF THE A. E. G. TWIN-ENGINED BIPLANE

wheels placed side by side, something like two V-chassis. This gives a very wide track, and should be strong for landing on rough ground. Steel is largely employed for constructional purposes throughout the machine.

1,500,000 Feet of Mahogany for Airplane Propellers

Clarence R. Mengel, president of the lumber concern of C. C. Mengel & Bros., Louisville, Ky., recently announced that he had signed a contract with authorities abroad calling for 1,500,000 feet of mahogany lumber for use in making airplane propellers. J. C. Wickliffe, secretary of the company, has just returned from Europe, where the contracts were drawn up. The mahogany will be cut in Honduras and Nicaragua. Mr. Wickliffe is quoted by newspapers as having said that while abroad he learned that it is the intention of Great Britain and France to put 40,000 new airplanes in service in 1917.

Bath, N. Y., Inventor Develops Big Plane

C. A. Hermann has been engaged at Bath, N. Y., for several months in the perfection of a battleship airplane. He has completed his model, and will take it within a few days to New York for inspection by purchasing agents of several European governments, as well as by army and navy officers of the United States, according to newspaper reports. The machine is said to combine many advantages, both in the facility with which it can be handled, as well as for its offensive and defensive features.

The machine has seven planes, arranged on the step forward plan, and its motive power is furnished by three large propellers, each driven by a separate motor capable of developing a total of more than 500 horsepower. In case of one or more motors being disabled, the injured member can be disconnected and the propelling power thrown upon the remaining motors.

The planes have a lifting surface of 3200 feet, it is claimed, and the machine is capable of carrying three tons besides its own weight. Its crew consists of five men. The guns designed for the machine are mounted upon a swivel-like carriage so that they can command a sweeping range, both laterally as well as perpendicularly. The cost of one of the machines will be from $35,000 to $50,000.

Admiral Peary Wants Huge Air Fleet

Unless this country builds a great fleet of airships, the millions it is spending on its Army and Navy will be wasted in the event of war, according to Rear-Admiral Robert E. Peary, the discoverer of the North Pole.

"The one great meaning of the present war, is that it is not only the command of the sea or the command of the land that counts in modern warfare," Admiral Peary said in a recent address. "This war in Europe has shown that command of the air is necessary to genuine defense.

"The millions we are putting into our Army and the millions we are putting into our Navy and into our coast defenses will be wasted unless we support these defenses with a great air fleet, and the defenses without this will be worthless. That is not all, however. The billions that have been put into building up our great coast cities and the millions put into the construction of the Panama Canal may be thrown away unless we have a great air fleet to help protect them."

The Curtiss Co. Issues New Notes

According to the *Financier*, the Curtiss Aeroplane and Motor Corporation has sold to a banking syndicate, headed by William Morris Imbrie & Company, $2,000,000 one to five year serial prior and convertible 6 per cent. notes, due in equal annual installments from January 1, 1918, to January 1, 1922, inclusive. The corporation has also sold to private interests $2,000,000 6 per cent. gold notes, due January 1, 1926. Both issues are callable at 102½. Purpose of this financing is to refund $1,000,000 of notes falling due January 1, $1,000,000 due April 1, and $1,000,000 falling due July 1, 1917. Holders of the April 1 notes will be offered the privilege of depositing their notes for payment at 102½, after January 2, 1917. The July 1 notes will be offered the same privilege, and notes not exercising that privilege will be called for payment on April 1, according to the terms of the call privilege contained in the notes.

The regular semi-annual dividend of 3½ per cent. on the preferred stock has been declared, payable January 15 to stock of record January 1.

The Aeronautic Exposition

The Pan American Aeronautic Exposition held in the Grand Central Palace February 8-15 was a success which reflected credit upon the organizers and exhibitors alike. It presented to the public a concrete demonstration of the state of the American aeronautical industry. Its educational effect could hardly be overestimated and at the same time it has given to American designers a much needed opportunity to view the industry as a whole and to secure the help which cooperation alone could afford.

The outstanding feature of the exposition was the clear illustration which it gave of the fact that sound aeronautical engineering is the all-important necessity of successful design. The industry is no longer a field for the inventor alone. It has been almost entirely reduced to a question of engineering. Flying and the building of machines to go in the air is governed by precisely the same general laws of gravity, stress, etc., as govern every other branch of engineering. American constructors realize this. The show was remarkable for the absence of "freaks."

Unfortunately the show also brought out even more clearly than it has been shown hitherto that there are very few types of machines on a production basis. The types exhibited included almost none but training machines and large machines of the training type but built for reconnaissance work. No machines carrying protective armor were to be seen and none which were built to mount machine guns. Although several companies are doing experimental work upon light enormously fast pursuit fighting machines none were exhibited. No bombers or heavy weight carriers were shown.

On the other hand the show made it clear that these problems will soon be solved. Up to last year it was impossible to attempt their solution because of the fact that no satisfactory engine was to be purchased in this country. But the engine development displayed at the show makes any further complaint about the quality of American engines of 140 horsepower and less impossible and we shall very soon have efficient engines of 200 and greater horsepower. The Launne engine being built by the General Vehicle Company of 100 horsepower was one of the features of the show. Its workmanship answers at once and effectively the foreign complaints against the skill of American mechanics. No finer workmanship is possible than it displays. American machines can be the peers of any in the world.

The Hispano-Suiza which could not be shown taken down because of the relations which the company that is building it has with the French Government is also a triumph of mechanical ability and skill. It develops 150 horsepower at 1400 revolutions per minute and is much smaller and far more compact than 150 horsepower engines we have known in this country hitherto.

The Curtiss 200 horsepower V cylinder, the new Thomas model 88 Aluminum 140 horsepower engine, the Sturtevant Aluminum 140 horsepower engine, the Wisconsin 8 cylinder 140 horsepower engine, the Curtiss OX 100 horsepower engine and the new 8 cylinder Aeromarine engine are all of them serviceable models as well as the four Hall-Scott engines which, because the factory is located on the Pacific Coast were not exhibited.

It only remains now to perfect production methods so that the day will soon come when quantity as well as quality will be available.

The trend of design towards larger and larger horsepowers is exhibited by such engines as the Knox 300 horsepower, the Packard 300 horsepower and the Wisconsin and Duesenberg engines which it is hoped will all be on a production basis in twelve months.

Lighter Than Air

Special interest in the show centered in the lighter than air craft makers and makers of accessories for dirigible and kite balloons. The rumor was current upon the first day of the show that the Navy Department was about to order its coast defense dirigibles or "Blimps." This rumor which was later confirmed, led many to examine carefully the booths of the United States Rubber Company, the Goodyear Tire and Rubber Company and the Connecticut Aircraft Company.

Wright Martin

Practically the entire ground floor space was devoted to airplanes.

The Wright-Martin Aircraft Corporation showed the original Wright flier of 1903 restored to exactly the condition in which it was used in its first flight. It afforded a striking contrast to the two modern two-place tractors which the company had on the floor — Martin 125 horsepower Model R and the two Wright-Martin Model V. This latter machine is equipped with an Hispano-Suiza 150 horsepower engine. Its simplicity and sturdiness of design are noteworthy. The small size of the Hispano-Suiza engine, enabling easy and compact installation and good streamline form, the simple landing chassis and the wing fittings all suggest that this model airplane is one which would lend itself to quantity production. The machine was shipped straight to the show from the Dayton-Wright flying field where it had been undergoing preliminary tests.

The company exhibited two models of Hispano-Suiza engines, an 8 cylinder V Type 150 horsepower and a 4 cylinder model of 75 horsepower. The 8 cylinder engine weighs but 445 pounds or about 3 pounds per horsepower.

The cylinders are made of aluminum with steel liners and are completely water jacketed. The valves are in the head and are actuated by an overhead camshaft which operates through cams working directly upon the hollow valve stems.

Two 8 cylinder Dixie magnetos are employed, each one firing a separate set of spark plugs and a special starting magneto geared to give a hot spark at low propeller speeds is employed. Lubrication is by forced feed and castor oil is used as the lubricant.

The cylinders are not staggered but forked connecting rods are employed. The design of the crankshaft bearings and connecting rods was not shown. It is said to display many novel and interesting features requiring the most minute mechanical accuracy.

The booth was one of the centers of attraction at the show. Glen L. Martin, Vice-President of the Wright Martin Aircraft Corporation and C. M. Vought were in charge. Orville Wright paid many visits and explained the principles of his original flier and E. M. Hagar, president of the corporation, also attended the show upon many evenings.

The Curtiss Exhibit

The center of interest for aviators and aeronautical engineers at the Curtiss exhibit was the J N-4 B training machine although the public was attracted and fascinated by the novel "autoplane."

The J N-4 B Curtiss is an airplane which has been perfected. For the purpose for which it is intended, training work, it is as good a plane as is built anywhere in the world. Years of development experience, engineering skill and aerodynamic research have been combined with careful factory methods in the production of a training tractor which could scarcely be improved upon.

The autoplane, a triplane pusher with a three passenger enclosed limousine body was the center of popular interest. It is equipped with a 100 horsepower engine driving a large four bladed propeller through shaft and chain mechanism.

A model L boat was exhibited and purchased by E. Frater Harrison of Eden Cove, New York.

The OX, OXX, V-3 and V-4 engines were on exhibition. The exhibit was in charge of F. L. Faurote. Glenn H. Curtiss spent several days at the show having returned from Florida where he is using one of the Curtiss engines for speed boat racing.

The L. W. F. Exhibit

The L. W. F. Engineering Company exhibited one of the 140 horsepower reconnaissance biplanes which it is building for the United States government in quantity. The machine showed a speed range of from 47 to 92 miles an hour in its official government tests. The main feature of this machine is its three ply laminated wood monocoque body. This has a better streamline form and is stronger and lighter than the usual wire stressed built-up construction. The exhibit was in charge of V. H. Flint, Vice-President and Archibald Black, Chief Engineer.

The Aeromarine Exhibit

An interesting exhibit comprising a training tractor biplane, a new eight cylinder engine and a float for a seaplane was on view in the booth of the Aeromarine Sales and Engineering Corporation.

The biplane is from designs of Charles Willard and will use a Hall-Scott 100 horsepower engine. The spread is 37 feet for the top plane and 33 feet for the lower plane and the surface is 420 square feet. The strut fittings, which do not pierce the wing spar, the special landing chassis designed with a view to readily removing the axle, the universal jointed wing attachment fittings and the bolts construction built for ease and speedy disassembly all tend to make this machine one well adapted for training purposes.

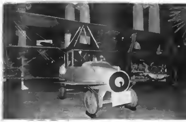
The Aeromarine Engine

The new engines are four-cycle eight cylinder V type geared down, with 3½ bore by 5⅝ stroke, high speed, designed to run at 2300 revolutions per minute with a reduction gearing. The crank case and its various parts are made from aluminum alloy.

The lower crank case contains sufficient oil for a five hour run at full power. Increased capacity can be provided when required. The oil pump is located in the lower part of the crank case and is driven by a ground spiral gear. Large passage ways are provided to take the oil from the lowest part of pump which is located at the centre and forces it through the crank shaft, cam shaft and gears. A pressure gauge is located on the instrument board where it can be observed at all times. By means of a pressure relief valve a constant pressure of 30 pounds is maintained on the oil within the crank shaft, the surplus oil pumped, going to the timing and propeller driving gears—the latter being oiled by means of the oil holes drilled through to the centre of the shaft. No "splash" is employed and no oil is allowed to remain in the upper crank case but is carried off to the reservoir. Only one screen is employed, one of large area and with a good sized plug at the bottom for dropping used oil.

The cylinders are in two blocks of four made from special cylinder aluminum

View of the Ground Floor of the Aero Show Taken from the Gallery



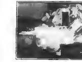
The Curtiss Autoplane

The Aeromarine Engine Plant and Float

castings. The liners are of vast iron hard steel to resist wear. The pistons are also of a special aluminum alloy. A very light wrist pin of large diameter is employed with hole to receive tapered bolt ends, leaving thickest metal in centre where greatest bending moment occurs.

The connecting rods are of I beam section forked and bushed to run on crank shaft with a brass bearing closely lined with white metal. These rods are machined to a nicety all over.

The crank shaft is short between end bearings and runs on three bronze bearings.



The Aeromarine Eight Cylinder Engine Showing Built in Delco Starting System

The cam shaft is forged with cams integral case hardened and supported by five bronze bearings. The cams are so arranged that each one actuates two valves through a rocker arm.

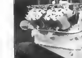
Delco ignition and starter are provided and are built in as an essential part of the motor. Two spark per cylinder are used the spark plugs being located at opposite sides of the cylinder head, which together with the valve in head arrangement, make a very powerful combustion chamber.

The carburetor is the Zenith twin barrel type supplying gas through a water jacket manifold.

The booth was in charge of H. B. Wise and Charles Willard, the designer of the plane as well as Mr Roland the designer of the engine who were constantly in attendance. Mr Inglis M. Uppercu president of the company, and secretary-treasurer of the Aircraft Manufacturers Association was also in the booth at all times.

The Thomas Morse Plane and Engine

At the Thomas-Morse Aircraft Company's booth a new biplane as well as two 8-cylinder engines were exhibited.



The Thomas Model 88 Aluminum Engine

The biplane was conspicuous because of the large controlling surfaces. It is similar to the ones that the government is ordering. A full description of the Thomas [illegible] appears elsewhere in this issue. Frank L. Morse, Wm. T. Thomas, Raymond Ware, Jerome A. Fried, H. H. Bliss and G. H. Abel were representing the company at the show.

The Standard Aero Corporation

The Standard Aero Corporation had one of the most educational exhibits at the show. The H-3 tractor plane which is driven by a 125 horsepower Hall-Scott engine was exhibited in every stage of construction. The stripped body gave a clear demonstration to engineers of the problems which have to be solved in building a successful airplane. The built up body with its trussing and cross bracing and its wire fittings and turnbuckles offers a definite problem of engineering if it is to be strong and light. Uncovered wing sections were displayed as well as a streamline for the top of the body and fittings were shown in the various stages of construction.

The exhibit was in charge of Ripley Bowlus and among the officers of the company who paid frequent visits were Harry Bowers Mingle, president of the Standard Aero Corporation and of the Aircraft Manufacturers Association and Charles H. Day, chief engineer and designer for the company.

The Burgess Exhibit

The Burgess Company of Marblehead Mass. exhibited the largest machine shown, an enormous seaplane with a 30 degree sweep back of the wings. This machine has been in constant use during the past winter. It was built for the United States government and is being prepared for use to test the practicability and value of the John Hays Hammond Jr. wireless controlled torpedo. An attractive booth showing pictures of the Burgess machines was also a part of the exhibit which was arranged by Frank H. Russell.

The Standard Aero Company's Exhibit

The Sturtevant Engine

The B. F. Sturtevant Company showed several of its Model 5 A 140 horsepower aluminum valve in the head eight cylinder V type engines. These engines were completely described in AVIATION AND AERONAUTICAL ENGINEERING for November 15th. B. N. Foss and Grover C. Loening were representing the company.

A Small Caudron

John D. Cooper exhibited a little Caudron-type seaplane, without engine, built for training and sporting purposes. The design of the fittings upon this machine showed considerable ingenuity and skill. Mr Cooper was in charge personally.

The S. S. Pierce Aeroplane Co.

A small sportsman's machine was shown at the S. S. Pierce Company's booth and attracted much attention. It was the smallest plane exhibited at the show, having but 24 feet spread on the top plane and 20 feet span on the lower plane. An Eiffel 32 wing section is used to give a high rate of climb. A monocoque body of careful construction attracted much attention from designers both of planes and of lighter-than-air craft. The engine installed is a 30 horsepower, 3 cylinder radial cast aluminum, air cooled design. At the booth were S. S. Pierce, Sidney S. Breese and Charles L. Lawrance.

The Witteman Tractor

A training tractor with an A-5 125 horsepower Hall-Scott engine was shown by the Witteman-Lewis Aircraft Company. The wing spars on this machine were spaced very close together so that the wing curve is maintained in correct shape at all times. The linen is shrunk before being sewed on the frames but after the frames are covered the wings are painted with material which contains shrinking qualities. Charles R. Witteman, Paul W. Witteman and S. J. Lewis arranged the exhibit.

The Benoist Plane and Roberts Engine

The Benoist Aeroplane Company showed a flying boat similar in type to those which the company has been manufacturing for several years but with several minor refinements. The boat is driven by a Roberts 2 Cycle six cylinder engine and the Roberts Motor Manufacturing Company had an exhibit in connection with the Benoist exhibit. A crankshaft for a twelve-cylinder engine was shown and attracted much attention because of its great size and light weight.

The S. S. Pierce Sportsman Tractor

The exhibits were in charge of Tom Benoist and A. J. Burke.

The Lawrence-Lewis Machine

An interesting exhibit was that of the Lawrence-Lewis Aeroplane Company of Chicago. While no machine was shown, the several large photographs displayed showing their model A 1 machine in flight together with the interesting data in connection with work done at their experimental camps near Tampa, Florida and Chicago were of particular interest to constructors and engineers. More than 150 flights were made during the year 1915 and 1916 without any means of controlling the lateral stability other than those inherent in the machine. The machine in appearance as well as in construction, departs widely from standard practice. It is so constructed as to permit of rising from or alighting on either land or water. While the lines of the machine are extremely graceful the impression given by the side view of the machine displayed in the photographs is that it is not possessed of any great amount of speed or efficiency. As a matter of fact, the machine is exceptionally efficient, and has an extremely wide speed range. In all of the experimental work done a Kirkham 45 h.p. engine was used.

The company has under construction at the present time two new machines, one of the speed type (model A 1) and the other of the load carrying type (model B 1). These machines will be equipped with 140 horsepower Hall-Scott engines and demonstrations will be made at Chicago. Harry L. Lewis and G. R. Lawrence were kept busy explaining the unique features of their machine.

The General Vehicle Company's Engine

The finest piece of mechanical apparatus which was on exhibition at the show was the 9 cylinder rotary 100 horsepower Gnome engine. The General Vehicle Company is manufacturing this engine for the British Admiralty and during the show the United States Army and United States Navy each ordered 50 of these engines. The wonderful workmanship of these engines answers once for all the oft repeated complaint that American mechanics are incapable of the best work. The skill shown in the construction of these engines could not be surpassed anywhere. The exhibit was in charge of F. N. Turk.

United States Rubber

The exhibits of lighter-than-air craft manufacturers attracted great attention. While the United States Rubber Company does not manufacture dirigibles or kite balloons its exhibition of balloon fabrics proved extremely interesting to all who knew of the Navy's plans to purchase lighter-than-air craft for coast defense. A complete and distinctive line of balloon fabrics and mechanical sundries for airplanes and aviators was shown including shock absorbers, gasoline hose and rubber matting, together with shoes and clothing for Aviators.

The United States Rubber Company has been manufacturing rubber products for 75 years and during the past two years its laboratories have given much attention to solving some of the problems connected with the uses of rubber in connection with national defense. The rubberized balloon fabrics shown were claimed to be light strong and gas tight. The booth was in charge of R. C. Fisher and H. B. Strawn.

The Connecticut Aircraft Exhibit

The Connecticut Aircraft Company, following its custom of producing the very latest types of dirigibles has lately developed and produced plans and a successful model of a new non-rigid dirigible of the "Blimp" or fuselage type. This type of dirigible was developed by the English Army. It is a radical departure from the standard type of dirigible in that while the bag follows closely the

The Connecticut Aircraft Company's Exhibit

usual type the gondola is entirely dispensed with and in its place there is suspended an airplane body. This very interesting type of dirigible is designed to carry two observers. It has a cruising radius of about ten hours. The gas bag which is about 135 feet long has a capacity of approximately 100,000 cubic feet which with the extreme lightness of load carried gives a large surplus of lift. The Blimp type is designed for a speed of 25 to 40 miles per hour. Its flight is controlled by steering rudders on the tail of the gas bag operated by leads from the pilot stand. There are two ballonets for pressure and for navigating purposes. The ballonets are controlled through a valve chamber. The valve chamber is suspended from the bag at an angle and its mouth is directly behind the single four blade tractor propeller. The air in the wake of the propeller is forced through the valve chamber into the ballonets. The fuselage is constructed of seamless steel tubing built to secure very light weight with extreme strength. The power plant consists of an 8 cylinder V type 140 horsepower motor. The fuel supply for ten hours flight is carried in storage tanks suspended above the pilot. Additional ballast is carried to allow very high flights.

The Connecticut Aircraft Company also showed models of the Navy dirigible DN1, a military observation balloon of the Parseval von Sigsfeld type and other lighter than air products. C. A. Smythe prepared the exhibit.

The Goodyear Kite Balloon

The Goodyear Exhibit

"Everything in rubber for aeronautics" has been the slogan of the Goodyear Tire & Rubber Company for the past six or eight years. To this end they have done a vast amount of research work and are now in a position to furnish the airplane manufacturers or the Government tires, tubes, rims and shock absorbers.

In the lighter-than-air craft field, the Goodyear Tire and Rubber Company have designed spherical balloons and kite balloons.

The kite balloon on exhibition was the outcome of experimental and research work by the Goodyear Company and it may be definitely stated, that the new Goodyear type kite balloon has points of superiority over any other kite balloon. The newest type can be flown without tail cups and will ride steadily at a point almost vertically above the winch.

Kite balloons are now almost universally recognized in nearly all modern warfare on land or sea.

The Goodyear Tire & Rubber Company has also gone into the matter of parachutes which are an absolute necessity as an accessory for kite balloons.

Although it is the policy of the Company not to announce anything to the public until it is thoroughly tried, tested and approved there is a rumor from substantial sources that the Goodyear Company is now very active in the construction of some non rigid dirigibles, both according to Goodyear design and of the most approved types abroad. They are fully equipped and ready to put out on a production basis and at short notice complete dirigibles, sphericals or kite balloons, and in the time of national crises the Goodyear Tire & Rubber Company will aid the Government with everything at their command in order that the United States lighter than air service may gradually be developed to the most efficient and resourceful in the world.

The exhibit was in charge of Ralph Upson, R. A. D. Preston and F. A. Seiberling.

The Sperry Exhibit

The Sperry Gyroscope Company showed the automatic pilot, a synchronized drift set, the Creagh-Osborne compass, the Sperry incidence indicator, an instructograph as well as a searchlight battery for night flying.

The engineering refinements and finish displayed by all of the Sperry Company's apparatus marked the exhibit as of peculiar interest to the engineer. The exhibit was in charge of T. A. Morgan.

The Davis Gun

A Davis non-recoil gun was placed in the show by vice-president Stone of the General Ordnance Company. This gun, which was described in the February 1st issue of AVIATION AND AERONAUTICAL ENGINEERING, enables an airplane to mount armament which will throw large sized projectiles and consequently do more damage than can be done by a machine gun.

The Wisconsin Exhibit

A Wisconsin 6-cylinder vertical engine and 12-cylinder V type engine were shown

these motors were described in detail in AVIATION AND AERONAUTICAL ENGINEERING for October 1, 1916. T. M. Leonard makes the change.

THE [illegible] KNOX EXHIBIT

This hundred horsepower is a monumental figure not seen in these large sums in these days but when one considers what is required to produce 300 horsepower in the large Knox Aeronautic engine one has a different understanding of the duties imposed.

Every time there is an explosion there is evolved a force of approximately six thousand pounds or three tons. There are six explosions per revolution so that every time the motor turns over there is imposed on the crank shaft a weight equivalent to that of a trolley car. Every minute the shaft has to stand a force equal to the weight of eighteen hundred trolley cars.

In one horsepower there is sufficient force to raise 33000 pounds one foot. In three hundred horsepower there is sufficient force every minute to raise nine million nine hundred thousand pounds or forty nine hundred tons a distance of one foot. The Knox Aeronautic motor swings a propeller fourteen feet in diameter twelve hundred revolutions per minute. The tip of the blade travels approximately ten miles per minute. There is a force of over twenty five tons tending to pull the propeller apart. Such figures give an idea of the forces that the aeronautic engine designer has to contend with.

Even with the economy of the Knox engine it uses twenty five and six tenths gallons of gasoline per hour, when delivering 313 horsepower at 1800 revolutions per minute. At its rated speed the piston travels back and forth at the rate of twenty-one hundred feet per minute and requires a force of a ton and a half to stop it each one of its thirty six hundred reversals of motion every minute. The engineers in charge of the motor were E. H. Gurney and E. J. Stone.

THE NEW JERSEY AEROPLANE COMPANY

Maximilian Schmitt exhibited two rotary engines of 85 rated horsepower weighing 245 pounds each. These engines are built in Paterson, N. J., and follow the general design of the French LeRhone, but Mr. Schmitt has added several original details.

THE DELCO EXHIBIT

The Dayton Engineering Laboratories exhibit contained various ignition lighting and starting devices which the company manufactures together with several of their special aeronautical equipments. A particularly interesting feature of the show was the installation of the Delco starting and ignition system in the Aeromarine engine shown by the Aeromarine Sales and Engineering Corporation. The starter is also on the Hispano Suiza engine used in the Model V Wright Machine which was flown at Dayton, Ohio and exhibited at the Show.

The Dayton Engineering Laboratories Company has gone extensively into aeronautical experimentation at their plant where they have a thoroughly equipped laboratory. Mr. E. A. Deeds, president of the company has recently presented to the City of Dayton a 300 acre flying field which is known as the Wright Field. This field is well within the city of Dayton itself. At the Delco plant the company has a field which it is using for actual flying tests of the Delco installations. C. M. Millard was kept busy explaining the advantages of the exhibit to visitors.

CLARENCE WHITMAN & CO

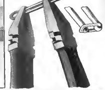
The Ponemah Mills were the pioneer manufacturers in this country of cotton balloon fabric. Today their material is used by the Goodyear Tire & Rubber Co., U. S. Rubber Co., the B. F. Goodrich Co. and the Hodgman Rubber Co. in the manufacture of rubberized cotton fabric for lighter than air craft.

The Ponemah Mills are now prepared to furnish a closely woven fabric as a substitute for linen for the flying surfaces of airplanes. This cloth has been tested by the Bureau of Standards & Weights at Washington and by several of the large airplane constructors with results which indicate that an effective substitute can be produced in this country for the rapidly diminishing supply of imported Irish linen. The result of the Bureau of Standards test is as follows:

Airplane 4 ounces to square yard, warp, 87 pounds; filling, 90 pounds; count, 275 threads square inch.

Balloon 2 ounces to square yard, warp, 47 pounds; filling 52 pounds; count, 300 threads square inch.

Testing 300 H. P. Packard Engine. Engineer ... at the Throttle



The Frank B. Cook Company's McCabe Sleeve for Wire Fastening

THE PACKARD ENGINE

The new twelve-cylinder Packard engine was one of the centers of interest. Three hundred Packard employees are busy at present trying to rush the production of tool jigs and dies for its manufacture. The peculiar feature of this engine is that the cylinder blocks are set at an angle of 40 degrees instead of 60 degrees as is usual in twelve cylinder V type engines. This makes the engine a comparatively simple one to install. The final engine is to have drop forged steel cylinders instead of cast iron cylinders such as appeared on the engine exhibited. W. B. Stout was in charge of the booth.

THE STANDARD SCREW CO

The Standard Screw Company of Corry, Pa., has been in business for two years and was incorporated about six months ago for the production in quantities of turnbuckles and other airplane fittings. The factory is devoted exclusively to the production of airplane turnbuckles, bolts and nuts. The products of this company comply with both the United States and British specifications for airplane fittings. The company has made large deliveries of turnbuckles which are installed in machines now in use abroad as well as for machines constructed for the United States Government and these turnbuckles are giving satisfaction in service.

Whitman & Co. exhibited their Fleetwing Flying Fabrics as their cotton airplane cloth and balloon fabrics are called. They sold over $50,000 worth of light balloon fabric during the second day of the show. The Fleetwing Flying Fabrics are manufactured in widths from 36 inches to 65 inches and in 150 yard pieces put up in rolls of 1,000 yards each. The grade of material is Sea Islands cotton of the longest staple obtainable. The Ponemah Mills are the only ones at present equipped to weave flying cloth in widths of 62 inches.

The representative of the Ponemah Mills at the Aeronautic Show was W. H. Thurston, Jr., who is in charge of the Mechanical Cloth Department of Clarence Whitman & Co.

THE FRANK B. COOK CO

A new method of fastening wire cable was shown in the McCabe sleeve by the Frank B. Cook Co. of Chicago. Sleeves for joining wires used in telephone and power work have been made by the company for many years.

For use on airplanes the sleeves consist of short paralleled tubes formed of specially rolled sheet copper. The butting edges of the formed sheet are well brazed and the sleeve thoroughly turned. After properly inserting the cable or wire the sleeve is twisted one and one-quarter times with special pliers. The end of the

cable is bent over inside of its tube and a sleeve formed.

The Frank B. Cook Co. claims that these sleeves offer a cheaper, quicker and more secure method of making joints than any hitherto employed. It reports that its numerous tests have shown all joints to hold to the breaking point of cable. Hundreds of test loops were made at the Cook booth and tested on apparatus made for the purpose.

The tests were chiefly made with Roebling 3/32 inch, 19 wire, galvanized aviator strand. This wire is rated at 1100 lbs but averaged about 1300 lbs at breaking point. The McCabe sleeve held perfectly in these tests. George R. Fubls, president, arranged the exhibit and Mr. McCabe made the tests.

Three Thousand Different Screw Machine Products All Used on One Airplane

ERIE SPECIALTY CO.

One of the most encouraging factors bearing upon the future of the aeronautical industry in this country is shown by the efforts towards standardization by many of the accessory manufacturers. This was forcibly illustrated at the show. The accessory manufacturers showed that they are willing and anxious to produce what the engineers want. Another important feature that illustrates the advance that is being made is the standardization work being done by officers of the Erie Specialty Company of Erie, Pa. The exhibit of this company was one of the most interesting and novel there. Every type of airplane fitting was shown graded according to various sizes and shapes. This company has data sheets on all their parts and will from time to time distribute supplementary figures on additional parts which they are prepared to furnish.

In the exhibit were shown 3,000 different screw machine products, all of which are used on one model of airplane which is being built in the United States today. This company in 1916 made 2800 different sizes and patterns of simple bolts alone. In view of these facts it is encouraging to note that the Erie Specialty Company in its efforts to introduce standardization is meeting with cooperation on the part of all constructors and on the part of the Society of Automotive Engineers. The company was represented by F. G. Diffin and C. L. Walker.

ABERCROMBIE AND FITCH

Abercrombie and Fitch showed a complete line of aviators' clothing. This clothing has found favor with American military aviators. Some of the designs are similar to the clothing worn by French and British aviators. Charles C. King represented the company.

JOHN A. ROEBLING SONS CO.

At the Roebling booth a clear exhibit of the different kinds and sizes of wire strand and cable made by the company was shown to the public by Horace E. Thorne and John J. Fitzpatrick.

Three separate and distinct sorts of wire are made, solid wire, strand, and cable or cord. The solid wire is furnished in diameters from .028 to .204 inches with breaking strengths from 175 to 6,700 pounds.

The stranded wire is composed of 19 wires stranded together and is furnished in diameters from 1/16 inch to 5/16 inch with breaking strengths from 500 to 12,700 pounds. A strand made up of 7 wires 1/32 inch in diameter with a breaking strength of 185 pounds is also manufactured.

The Kenebry & Mattison Hangar Exhibit

Roebling Aviator Cord is a softer wire used for controls. One grade is composed of seven strands of 19 wires each and the other of six strands of seven wires each with a cotton center.

Another grade of cord consists of seven strands of 19 wires each and is furnished in diameters from 1/8 inch to 3/8 inch with breaking strengths from 2,000 to 14,400 pounds. The aviator cord with cotton center is furnished in diameters from 1/16 inch to 5/16 inch with breaking strengths from 400 to 7,900 pounds.

Aviator cord is also made with seven strands of seven wires each in diameters from 1/16 to 5/16 inch with breaking strengths from 485 to 9,200 pounds.

TAYLOR INSTRUMENT COMPANIES

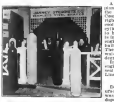
At this company's booth were exhibited the different pattern barometers and inclinometers manufactured for the industry in their Rochester, N. Y., factory. The impossibility of procuring altitude barometers from the English factory necessitated the development of this industry in this country and as the Taylor factory boasts of "a factory of mechanics" and as they had contact with their London, England, plant, it was only natural it should commence with them.

The Signal Corps and the U. S. Navy use "Tyco" barometers for their airplanes exclusively as do the leading manufacturers of the country. The representative machines at the Show were equipped with them.

The addition of radium material to the dial in order that it may readily be seen at night adds greatly to the value of the instrument.

The dials are all prepared with a very high grade of "Marvette" made by the Cold Light Manufacturing Co. of Denver, Colorado, a subsidiary of the Schlesinger Radium Company. This material is guaranteed to derive its luminosity solely from the stimulating effect of radium and is guaranteed to be permanent for all practical purposes.

Among the other interesting instruments were the Cyclo Stormograph, an instrument for foretelling the weather 12 to 24 hours in advance. This is used at a large number of coast stations and is especially valuable for aviators. The portable recording thermometer was also shown with maximum and minimum and other types of thermometers made by this company. T. R. Jameison and M. J. Carroll were at the show and showed the Taylor instruments to many interested constructors.



Mr. Steinmetz and the Exhibit of the Janney Steinmetz Seamless Tanks

AJAX RADIATORS

A complete line of radiators for airplanes was on exhibition at the booth of the Ajax Auto and Aero Sheet Metal Company. This company showed an upright radiator of small size but large cooling area for use with Hall Scott 6-cylinder engines. This radiator is built to be mounted on top of the engine and is in use in connection with the Hall-Scott engines which are mounted in the planes built by the Standard Aero Corporation. The radiators are small and light yet the water temperature is maintained at 110 degrees Fahrenheit constantly.

Intake and exhaust pipes for airplane engines were also shown by the representatives of the Ajax company, Messrs. Linder and Meyer of New York.

THE DUPONT CHEMICAL WORKS

Dope for airplane wing coverings manufactured by the Dupont Chemical Works was exhibited at one of the booths. This dope, which is used on nearly 90 per cent of the airplane wings now being manufactured in the United States, has the dis-

that advantage for factory purposes that it is non-poisonous. Dupont dope is extremely flexible yet at the same time is tough and strong. Its waterproofing quality protects the wings of the machine even when it is subjected to severe weather conditions. The dope also insures correct shrinkage when applied to wing coverings made of high quality linen or cotton fabrics. The booth was in charge of R. L. Vilas.

HOWELL, FIELD AND GODDARD

The solution of the hangar problem has been reached by the firm of Howell Field and Goddard of Long Island City.

The Howell Field & Goddard Model Hangar

this solution is the result of standardization. Structural steel is used with specially designed truss units so that a building can be furnished in any multiple of eight feet as may be desired. The hangars are of heavy galvanized iron designed with an ample factor of safety against wind pressure and snow loads.

The entire front of the hangar is arranged to open in sections of eight feet width each by opening the specially constructed counterbalanced doors. These doors are raised upward by a simple mechanism in which the likelihood of derangement has been reduced to a minimum. The hangars were exhibited by means of an exact scale model 1/12 size which was shown by Benjamin Kerber. Mr. Goddard also spent a great deal of time at the booth.

OTHER EXHIBITORS

The following accessory makers also exhibited the products mentioned:

THE ALUMINUM CASTINGS CO., of Cleveland, O., represented by J. E. Diamond and B. Dyer, showed their well known products, Lynite and Lynux.

THE AMERICAN PROPELLER & MANUFACTURING CO., of Baltimore, Md., displayed a complete collection of two and four bladed propellers. Their booth was in charge of Spencer Heath, president of the company.

THE AMERICAN BRONZE CO., of Berwyn, Pa., represented by J. W. Watson, president of the company, had on exhibition a very complete collection of castings, bushings, and bearings.

THE BOSCH MAGNETO CO., of New York, with G. J. Lang in charge, presented their types of magneto ignition systems.

THE BUCK AIRCRAFT & MUNITION CO., of Denver, Colo., with Dr. Buck himself in charge of the exhibit, demonstrated and explained their aerial torpedo.

THE CHAMPION IGNITION CO., of Flint, Mich., represented by A. C. Champion, had on display an attractive exhibit of A. C. spark plugs of types designed for aeronautics.

CHRISTENSEN ENGINEERING CO., of Milwaukee, Wis., displayed their engine starter with E. B. Leverenz in charge of the exhibit.

THE COLD LIGHT MFG. CO., of Denver, Col., represented by Dr. Victor C. Thorne, showed the "Marvellite" radium compound manufactured by them.

CUTTING & WASHINGTON displayed an installation of radio apparatus and wireless outfit upon which messages were sent and received.

THE DOEHLER DIE CASTINGS CO., of Newark, N. J., represented by I. Honig, had an exhibit of die castings.

THE DUESENBERG MOTOR CO., of St. Paul, Minn., had on exhibit a twelve cylinder 300 horsepower engine which it was stated would develop 400 horsepower at 2100 revolutions per minute, the weight of the engine being 980 pounds equipped with electric starter.

THE GIBO MOTOR CO., of Washington, D. C., represented by Joseph Sanders, displayed their types "K" and "L" of 90 and 100 horsepower engines.

THE HAYNES MANUFACTURING CO., of Detroit, Mich., showed sheet metal parts and stampings manufactured by them for the automobile trade and which they hope to develop for the use of aeronautics.

HERBERT & HUESGEN, of New York, had on exhibit their well known cameras specially constructed for aerial photographic work.

JANNEY, STEINMETZ & CO., of Philadelphia, exhibited steel tanks of their design and construction.

KEISSEL & MATTISON, of Ambler, Pa., represented by George P. Brock and A. I. Harlan, had on exhibit one of the asbestos hangars for dirigibles, many of which they have made for foreign governments.

MCCORD MFG. CO., of Detroit, displayed radiators, forced feed lubricators and McKim gaskets.

THE MOTOR COMPRESSOR CO., of Newark, N. J., represented by George J. Soehrer, showed a complete collection of the starters manufactured by them.

THE MOTO METER CO., of Long Island City, N. Y., represented by George H. Townsend, president, exhibited the well known type of heat indicators made by them.

THE NEW YORK AND HAGERSTOWN METAL STAMPING CO., of New York and Hagerstown, Md., exhibited the recently invented Bellinger turn buckle.

THE NORTH EAST ELECTRIC CO., of Rochester, N. Y., represented by J. C. Halblick, exhibited electric starters for engines.

PARIANO AERIAL NAVIGATION COMPANY OF AMERICA, INC., exhibited a model of their aero ambulance.

PYRENE MANUFACTURING CO., of New York, represented by J. P. Maloney, showed their fire extinguishers.

THE RADIUM CHEMICAL CO., of Pittsburgh, Pa., represented by Joseph A. Kelly, displayed their luminous compound and had a dark room for better observation of its effect.

THE REINFORCED PROPELLER & INSULATING CO., of New York, exhibited a steel propeller of their design.

THE REMY ELECTRIC CO., of Anderson, Ind., and Detroit, Mich., represented by G. V. McMahon and W. E. Burton, had a very complete line of their electric starters, lighting generators and ignition devices.

SO-LUMINUM MFG. & ENGINEERING CO., of New York, had an exhibit, in charge of their president, George L. Upshur, of their welding compound for aluminum.

A. G. SPALDING & BROS., of New York and Chicago, presented a complete collection of aviators clothing.

THE SPLITDORF ELECTRIC CO., of Newark, N. J., represented by W. J. Harr Scholl and L. Werner, showed their magnetos specially designed for aerial service.

STANDARD PARTS CO., of Cleveland, Ohio, represented by B. G. Dodge, showed their lines and bearings manufactured now for automobiles but applicable also for airplanes.

STATEN ISLAND AVIATION SCHOOL had on exhibition their "Robin Hood" airplane in charge of B. G. Grundy, Jr.

THE STROMBERG MOTOR DEVICES CO., of Chicago, displayed a complete line of carburetors in charge of their New York manager, P. Morse.

H. L. F. TREBERT ENGINE WORKS, of Rochester, N. Y., showed a sixteen cylinder rotary engine.

THE SOCIETY OF AUTOMOBILE ENGINEERS had an interesting booth showing standards adopted and practices recommended.

THE UNITED STATES GOVERNMENT was represented in displays of the Army and Navy, the Weather Bureau, the Post Office Department, the Department of Commerce and the United States Coast and Geodetic Survey.

VALENTINE & CO., of New York, presented a display of dope for airplane construction.

VACUUM OIL CO., of Rochester, N. Y., had an exhibit in charge of their New York manager showing a complete line of lubricants manufactured by them.

THE WORLDS MOTOR CO., of Bloomington, Ill., exhibited, under the direction of F. W. Aldridge, president, a model of the latest type of the two cycle, five cylinder Fredrickson engine.

A Monoplane with a Steam Rotary Motor

John Wilson of Hutchinson, Kans., is reported to have finished a steam driven monoplane. The machine is claimed to be the only steam rotary motored monoplane in the United States. The designer has studied this type of engines for more than ten years. He built nine other engines before this his tenth one satisfied him. The machine was set up in a local factory. He has the machine almost ready for exhibition at the Kansas state fair, and after the fair, during which time he will test it, he expects to be able to pilot the machine on its first flight.

The machine is 25 feet long, with a streamline body, tapering from three feet in diameter at the front, to a point. It is made of well-seasoned spruce, guyed with A. I. steel guying wire, and the body covered with sheet aluminum. The body has a hood of heavy hammered copper. The planes are 35 feet wide, and have a wing surface of 240 sq. feet. The machine weighs 850 lbs. and has a lifting capacity of 1,200 pounds at 30 miles per hour. The weight includes machine, motor, passengers and fuel, and it is claimed for the monoplane that it can make 90 miles an hour.

A steering apparatus, having a three-in-one movement, is a part of the equipment, and the tail planes, rudder and elevator are of the inverse curve type. The wheels are streamline, made of solid metal, and fitted with pneumatic tires.

STEAM POWER PLANT

The engine, which with its generator weighs but 300 pounds, is known as the Wilson Brothers Steam Rotary motor. It is designed and built by John Wilson.

When Certainty of Speed and Reliability of Power

are required by Uncle Sam's flying men the demand is thoroughly answered by the 1917

Indian Motocycle
With Powerplus Motor

Its construction of highest quality materials mechanical simplicity, positiveness of performance in emergency enduring strength great speed and power and response to the slightest touch never have been equaled

Demonstrations of 1917 Indian models will gladly be arranged on request for interested military officials

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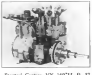

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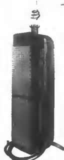

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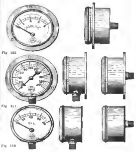

Fig 152

Fig 151

Fig 150

FOR GASOLINE, OIL, AIR, STARTING DEVICES, ETC.

Give constant readings while motor is running

Diameter of dial, 2 inches

Size of connections, 1/8" male or female iron pipe.

Pressures range from 4 lbs. to 300 lbs.

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SPECIFICATIONS

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Span Top 32 ft., bottom 22 ft.
Length Overall 23 ft. 9 in.
Chord 4 ft. 6 in. Gap 4 ft. 6 in.
Wing Curve N. P. L. No. 6.
Main Supporting Surface, 245 sq. ft.
Stabilizer 18 sq. ft.
Elevators 18 sq. ft.
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